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Original Article

Dentistry Section

Effect of Erosive Challenges on Microhardness of Three Different Nanocomposites: An In-vitro Study

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ABSTRACT

Introduction: The loss of tooth structure in natural tooth can be attributed to several aetiological factors like dental caries, traumatic injuries and non carious lesions like attrition, abrasion, erosion. All the lesions result in loss of enamel and dentin which eventually need to be replaced with restorative materials.

Aim: To evaluate the effect of different acidic solutions on the surface microhardness of three different nanocomposite restorative materials after one day and six weeks time interval.

Materials and Methods: The present in-vitro study comprised of three different composite resin materials, Filtek Z 350 (3M ESPE, St. Paul, USA), Ceram X Mono (Dentsply, Konstanz, India) and Tetric N Ceram (Ivoclar Vivadent, Schaan, Liechtenstein). Twenty four samples were divided into three groups. Group I: Eight specimens of each restorative material were immersed individually in 10 mL of artificial saliva. Group II: Eight specimens of each restorative material were immersed in artificial saliva for four hours and later immersed for five minutes in a tube containing 10 mL of coca cola under stirring and later stored in artificial saliva. This process was repeated for three times a day. Group III: Eight specimens of each test material were individually immersed in artificial saliva for four hours and later immersed in 10 mL of hydrochloric acid (HCl) for five minutes under stirring and later stored in artificial saliva. This process was done three times a day. Vicker's diamond indenter was used to test the microhardness. Paired t-test, independent t-test, one-way Analysis of Variance (one-way ANOVA) and post hoc test were used for analysis.

Results: There was no significant statistical difference (p-value >0.05) in the surface microhardness between all the tested solutions after day 1 time period of Filtek Z 350. There was significant difference of the surface microhardness between all the groups in all the solutions except for Filtek Z 350 and Ceram X Mono in HCl solution at 6 weeks.

Conclusion: There was statistically significant reduction in surface microhardness of the three composites immersed in all the three solutions of artificial saliva, coca cola and hydrochloric acid after day 1 and six weeks time interval.

Keywords: Ceram X mono, Filtek, Hydrochloric acid, Tetric N ceram

INTRODUCTION

One of the most important recent advances in this field of Endodontics and Conservative Dentistry is the introduction of nano materials by combining nanometric particles in a conventional resin matrix. The essence of nanotechnology is in the production and manipulation of materials and structures in the range of about 0.1 nm to 100 nm by various physical or chemical methods [1]. Nanotechnology is of great interest in resin composite research to satisfy the esthetic demands and mechanical strength. One consequence of applying the reduced size particles is that an increase in filler loading can be achieved. Many mechanical properties have been improvised due to the nanotechnology like high tensile strength, resistance to fracture, reduced polymerisation shrinkage, decreased wear rate and improved gloss retention [2]. Even though restorative materials replaced the hard tissues of enamel and dentin, wear is a factor which affects the longevity of restoration. In the oral cavity, a lot of components contribute to the wear of restorative material, such as the occlusal contacts to antagonist teeth (attrition), chewing on food items, tooth brushing with toothpaste or inhalation of dust (abrasion), acid attacks (erosion) cases [3].

Filtek Z 350 XT universal restorative is a visible light-activated composite designed for use in anterior and posterior restorations. The filled matrix (resin plus engineered nanoparticles) is harder and more wear resistant than resin alone. The increased filler loading results in better physical properties and wear resistance [3].

Ceram X is a light curable, radiopaque restorative material for anterior and posterior restorations of permanent teeth. It is manufactured by nano ceramic technology. The homogeneous dispersion and complete resin wetting of nano sized filler particles is desired to improve the aesthetic and mechanical properties of composites and is the subject of nano-technology developments. Ceram X offers high resistance to microcrack propagation due to the strengthening effect of the nano ceramic particles. Propagating cracks are either more often reflected or absorbed by the nano ceramic particles [3].

Tetra N Ceram resin matrix mainly consists of Bis-GMA, UDMA of about 15% and ethoxylated Bis-EMA (3.8%). Bis-EMA mainly decreases the viscosity of the resin. Trace amounts of additives, stabilisers, catalysts, pigments are also present. The mean particle size of microfiller is 0.6 μm, which improved the wear resistance of Tetric N ceram. Resin matrix also consists of prepolymers of about 17%. A microfilled composite is polymerised and milled to a grain size that can be employed as filler in a dental material. Such fillers are called "prepolymers" or 'isofillers" [3].

The aetiology of dental erosion is conventionally divided into "extrinsic" and "intrinsic" factors. Any of the acidic products that we eat and drink, and the occupation related erosion like workers in certain industries like battery making and galvanising industries, or people who are wine taster, are considered as "extrinsic" factors. The "intrinsic" factors includes eating disorders and Gastroesophageal Reflux Disease (GERD), vomiting and regurgitation, which leads to an influx of acidic stomach content into the oral cavity [4]. There has been a considerable increase in the intake of soft drinks in recent decades, and these often are high in acidic content and the common intrinsic cause for erosion is gastric regurgitation containing highly acidic gastric secretions [4]. These low pH solutions have influence on the wear of surface microhardness of restorative materials.

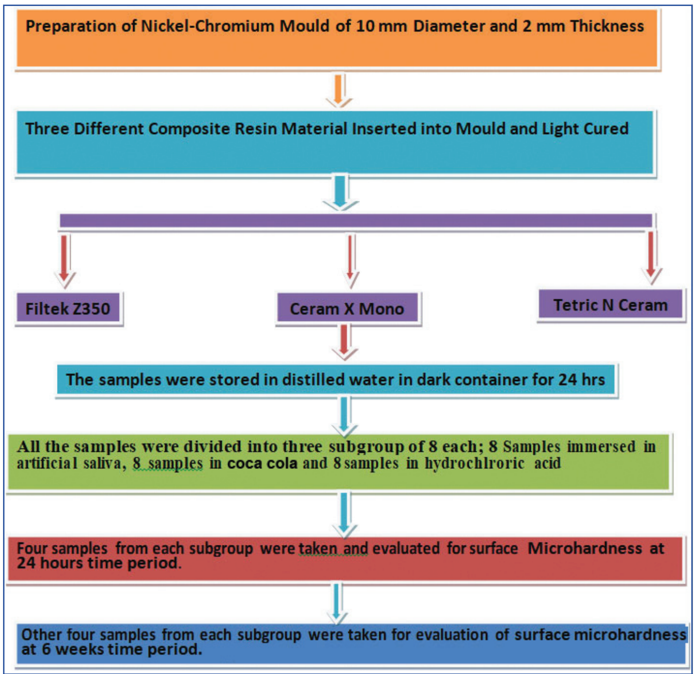
Thus, the aim of this in-vitro study was to evaluate the effect of different acidic solutions on the surface microhardness of three different nanocomposite restorative materials at one day and six weeks' time interval.

MATERIALS AND METHODS

Sample preparation and the materials used are tabulated in [Table/Fig-1,2].

Materials	Category	Manufacturer	Batch no.	Shade
Filtek Z 350	Nanofilled	3M ESPE St Paul, MN USA.	8RF	A2
Ceram X Mono	Nanohybrid	Dentsply, Konstanz, Germany.	1401000087	M2
Tetric N Ceram	Nanohybrid	Ivoclar Vivadent, Schaan, Liechtenstein.	S24541	A2

[Table/Fig-1]: Showing the different composite materials used.



[Table/Fig-2]: Procedure flowchart.

Sample Preparation

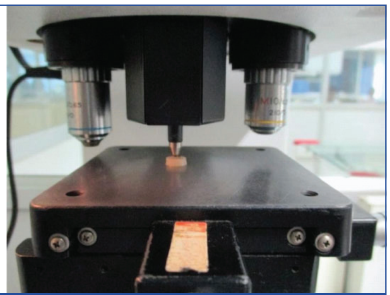
A nickel-chromium mould of diameter 10 mm and thickness of 2 mm was fabricated. The three different composite resin materials were used in the study were: Filtek Z 350 (3M ESPE, St.Paul, USA), Ceram X Mono (Dentsply, Konstanz, India) and Tetric N Ceram (Ivoclar Vivadent, Schaan, Liechtenstein). The composite resin material from each test material was inserted into mould cavity in a single increment with teflon coated instrument and covered with a mylar strip.

To compact the material and prevent void and bubble formation, a microscopic slide of standard size was placed over the mould assembly to allow for fabrication of specimen with flat surface. After 30 seconds, the resin composite increment was cured through the glass slide for 40 seconds using a LED Bluephase light curing unit (Bluephase, Ivoclar vivadent, India). Later, all the samples were stored in distilled water at 37°C for 24 hours in a dark container.

Later, the specimens of each test material (n=24) were divided into three subgroups based on immersion solutions- eight of each composite test material in artificial saliva, eight in coca cola and eight in HCl. Total sample size of 72 was included.

Group I: Eight specimens of each restorative material were immersed individually in 10 mL of artificial saliva.

Group II: Eight specimens of each restorative material were immersed in artificial saliva for four hours and later immersed for five minutes in a tube containing 10 mL of coca cola with pH 2.6 under stirring, later stored in artificial saliva. This process was repeated for three times a day.



[Table/Fig-3]: Vickers microhardness testing machine. **[Table/Fig-4]:** Vickers indenter on composite disc. (Images from left to right)

Group III: Eight specimens of each test material were individually immersed in artificial saliva for four hours and later immersed in 10 mL of 32% concentrated hydrochloric acid (HCl) with pH of 2.6 for five minutes under stirring, later stored in artificial saliva [3]. This process was done three times a day.

Four samples from each subgroup were taken for evaluation by Vickers surface microhardness testing after 24 hours and the other four samples were taken for microhardness evaluation after 6 weeks. Vicker's diamond indenter was used in a microhardness tester (Meta tech, India) for specimen indentation [Table/Fig-3,4].

STATISTICAL ANALYSIS

STATACORP (2012) Stata statistical software: Release 12.1. Stata Press, College Station was used. One way Analysis of Variance (one way ANOVA) and post hoc test were used for multiple variant analysis. The p-value of ≤0.05 was considered significant.

RESULTS

Intragroup analysis using paired t-test. Data after day 1 [Table/Fig-5-7] and six weeks intergroup comparison was done using Independent t-test. Intergroup analysis of the three composites in three different solutions at day 1 time period is shown in [Table/Fig-8]. Vickers Hardness Number (VHN) of three different composites in three different solutions at six weeks time period is given in [Table/Fig-9]. Mean surface microhardness of three different composites in different solutions at day 1 and six weeks time period is shown in [Table/Fig-10].

There was significant statistical difference in the surface microhardness between control and coca cola group; control and HCL groups of Ceram X Mono at day 1 time period [Table/Fig-5].

At day 1 time period, the intragroup analysis of Filtek Z 350 was non significant (p-value >0.05). This indicates that there was no significant

Variables	Paired differences					t	df	p-value
				95% Confidence interval of the difference				
	Mean	Std. Deviation	Std. Error mean	Lower	Upper			
Pair 1 Control cola	4.12500	1.94658	0.97329	1.02756	7.22244	4.238	3	0.024*
Pair 2 Control-HCl	5.77500	2.62345	1.31173	1.60050	9.94950	4.403	3	0.022*
Pair 3 Coca cola HCl	1.65000	2.37417	1.18708	-2.12783	5.42783	1.390	3	0.259

[Table/Fig-5]: Intragroup analysis of Ceram X Mono at day 1 time period.
Control=Artificial Saliva; One-way ANOVA test followed by post hoc test; p-value ≤0.05 is considered significant: *indicate significant p-value

Variables	Paired differences					t	df	p-value
	Mean	Std. Deviation	Std. Error mean	95% Confidence interval of the difference				
				Lower	Upper			
Pair 1 Control-cola	2.85000	1.83030	0.91515	-0.06242	5.76242	3.114	3	0.053
Pair 2 Control-HCl	0.97500	1.83553	0.91776	-1.94574	3.89574	1.062	3	0.366
Pair 3 Cola-HCl	-1.87500	2.27651	1.13826	-5.49744	1.74744	-1.647	3	0.198

[Table/Fig-6]: Intragroup analysis of Filtek Z 350 at day 1 time period Control=Artificial Saliva.
One-way ANOVA test followed by post hoc test

Variables	Paired differences					t	df	p-value
	Mean	Std. Deviation	Std. Error mean	95% confidence interval of the difference				
				Lower	Upper			
Pair 1 Control-Coca cola	1.70000	2.19545	1.09772	-1.79345	5.19345	1.549	3	0.219
Pair 2 Control-HCl	3.62500	0.98107	0.49054	2.06390	5.18610	7.390	3	0.005*
Pair 3 Coca cola HCl	1.92500	2.13288	1.06644	-1.46888	5.31888	1.805	3	0.169

[Table/Fig-7]: Intragroup analysis of Tetric N Ceram at day 1 time period Control=Artificial Saliva.
One-way ANOVA test followed by post hoc test; p-value ≤0.05 is considered significant:
*indicate significant p-value

Dependent variable			Mean difference (I-J)	Std. Error	p-value	95% confidence interval	
						Lower bound	Upper bound
Control	Filtek	Ceram	-8.00000	0.78	<0.005	-10.30	-5.70
		Tetric	-11.7500	0.78	<0.005	-14.05	-9.45
	Ceram	Filtek	8.00000	0.78	<0.005	5.70	10.30
		Tetric	-3.75000	0.78	<0.005	-6.05	-1.45
	Tetric	Filtek	11.75000	0.78	<0.005	9.45	14.05
		Ceram	3.75000	0.78	<0.005	1.45	6.05
Coca cola	Filtek	Ceram	-6.72500	0.89	<0.005	-9.33	-4.12
		Tetric	-12.9000	0.89	<0.005	-15.51	-10.29
	Ceram	Filtek	6.72500	0.89	<0.005	4.12	9.33
		Tetric	-6.17500	0.89	<0.005	-8.78	-3.57
	Tetric	Filtek	12.90000	0.89	<0.005	10.29	15.51
		Ceram	6.17500	0.89	<0.005	3.57	8.78
HCl	Filtek	Ceram	-3.20	1.13	0.06	-6.52	0.12
		Tetric	-9.10000	1.13	<0.005	-12.42	
	Ceram	Filtek	3.20	1.13	0.06	-0.12	6.52
		Tetric	-5.90000	1.13	<0.005	-9.22	-2.58
	Tetric	Filtek	9.10000	1.13	<0.005	5.78	12.42
		Ceram	5.90000	1.13	<0.005	2.58	9.22

[Table/Fig-8]: Intergroup analysis of the three composites in three different solutions at day 1 time period Control=Artificial Saliva.
One-way ANOVA test followed by post hoc test; p-value ≤0.05 is considered significant:
*: Indicate significant p-value

statistical difference in the surface microhardness between all the tested solutions at day 1 time period of Filtek Z 350 [Table/Fig-6].

There was statistically significant difference in the surface microhardness between control and HCl group of Tetric N Ceram at day 1 time period [Table/Fig-7].

There was significant difference of the surface microhardness between all the groups in all the solutions except for Filtek Z 350 and Ceram X Mono in HCl solution [Table/Fig-8].

[Table/Fig-9,10] shows the of Vickers hardness number of three different composites in three different solutions at day 1 and six weeks time period respectively.

When the intergroup analysis were done with the three different composites at day 1 and six weeks time, there was a significant decrease in the microhardness between the tested groups [Table/Fig-11-13].

There was significant statistical decrease in the surface microhardness between all the tested solution groups of Filtek Z 350 at day 1 and six weeks time period. There was significant statistical decrease in the surface microhardness between all the tested solution groups of Ceram X Mono at day 1 and six weeks time period. There was significant decrease in the surface microhardness between all the tested solution groups of Tetric N Ceram at one day and six weeks time period.

Solution	Sample number	Filtek Z 350	Ceram X mono	Tetric N ceram
Artificial saliva	Sample 1	72.4	80.9	84.3
	Sample 2	74.3	81.2	86.2
	Sample 3	72.1	79.8	85.4
	Sample 4	73.2	82.1	83.1
	Mean value	73	81	84.75
Coca cola	Sample 1	71.9	76.4	82.4
	Sample 2	70.1	78.2	83.6
	Sample 3	69.8	77.5	81.7
	Sample 4	68.8	75.4	84.5
	Mean value	70.15	76.85	83.05
HCl	Sample 1	70.9	78.1	81.9
	Sample 2	71.2	74.3	82.6
	Sample 3	73.4	75.2	80.6
	Sample 4	72.6	73.3	79.4
	Mean value	72.05	75.225	81.125

[Table/Fig-9]: Values of Vickers hardness number of three different composites in three different solutions at day 1 time period.

Solution	Sample number	Filtek Z 350	Ceram X mono	Tetric N ceram
Artificial saliva	Sample 1	60.4	72.1	77.1
	Sample 2	59.6	73.4	78.2
	Sample 3	61.2	71.9	76.4
	Sample 4	60.1	74.6	76.9
	Mean value	60.32	73	77.15
Coca cola	Sample 1	52.1	65.2	70.9
	Sample 2	51.6	66.1	71.4
	Sample 3	49.6	64.7	69.6
	Sample 4	54.2	66.6	71.9
	Mean value	51.87	65.65	70.95
HCl	Sample 1	49.4	63.2	69.2
	Sample 2	50.3	64.1	68.7
	Sample 3	51.6	62.9	68.4
	Sample 4	51.1	64.7	67.5
	Mean value	50.6	63.725	68.45

[Table/Fig-10]: Values of Vickers hardness number of three different composites in three different solutions at six weeks time period.

Equality of variables		Levene's test for equality of variances: F	Sig.	T-test for equality of means: t	df	p-value	Mean difference	Std. Error difference	95% confidence interval of the difference: Lower	Upper
Control	Equal variances assumed	0.829	0.398	21.30	6	0.005	12.68	0.59	11.22	14.13
	Equal variances not assumed			21.30	5.293	0.005	12.68	0.59	11.17	14.18
Cola	Equal variances assumed	0.312	0.597	15.97	6	0.005	18.28	1.14	15.47	21.08
	Equal variances not assumed			15.97	5.303	0.005	18.28	1.14	15.38	21.17
HCl	Equal variances assumed	0.679	0.442	28.16	6	0.005	21.43	0.76	19.56	23.29
	Equal variances not assumed			28.16	5.770	0.005	21.43	0.76	19.55	23.30

[Table/Fig-11]: Intragroup analysis of Filtek Z350 at day 1 and six weeks time interval.
One-way ANOVA test followed by post hoc test; p-value ≤0.05 is considered significant; *: Indicate significant p-value

Equality of variables		Levene's test for equality of variances: F	Sig.	T-test for equality of means: t	df	p-value	Mean difference	Std. Error difference	95% Confidence interval of the difference: Lower	Upper
Control	Equal variances assumed	0.840	0.395	10.160	6	0.001*	8.00000	0.78740	6.07330	9.926
	Equal variances not assumed			10.160	5.580	0.001*	8.00000	0.78740	6.03764	9.9623
Cola	Equal variances assumed	0.912	0.376	14.958	6	0.001*	11.22500	0.75042	9.38880	13.06
	Equal variances not assumed			14.958	5.359	0.001*	11.22500	0.75042	9.33420	13.115
HCL	Equal variances assumed	1.458	0.273	10.329	6	0.001*	11.50000	1.11337	8.77569	14.22
	Equal variances not assumed			10.329	3.934	0.001*	11.50000	1.11337	8.38821	14.611

[Table/Fig-12]: Intragroup analysis of Ceram X Mono at day 1 and six weeks time interval.
One-way ANOVA test followed by PostHoc test; p-value ≤0.05 is considered significant; *: Indicate significant p-value

Equality of variables		Levene's test for equality of variances: F	Sig.	T-test for equality of means: t	df	p-value	Mean difference	Std. error difference	95% confidence interval of the difference: Lower	Upper
Control	Equal variances assumed	1.984	0.209	9.825	6	0.001*	7.60000	0.77352	5.70726	9.49274
	Equal variances not assumed			9.825	4.730	0.001*	7.60000	0.77352	5.57701	9.62299
Coca Cola	Equal variances assumed	0.667	0.445	15.224	6	0.001*	12.10000	0.79477	10.15526	14.0447
	Equal variances not assumed			15.224	5.706	0.001*	12.10000	0.79477	10.13072	14.0692
HCl	Equal variances assumed	3.135	0.127	15.972	6	0.001*	12.67500	0.79359	10.73315	14.6168
	Equal variances not assumed			15.972	4.431	0.001*	12.67500	0.79359	10.55360	14.7964

[Table/Fig-13]: Intragroup analysis of Tetric N Ceram at day 1 and six weeks time interval.
One-way ANOVA test followed by post hoc test; p-value ≤0.05 is considered significant: * indicate significant p-value

[Table/Fig-14] shows intergroup analysis of the three composites in three different solutions at six weeks time period. There was significant statistical difference of the surface microhardness between all the three composite groups in all the tested solutions at six weeks time period.

DISCUSSION

The reasons of dental erosion can be classified into "extrinsic" and "intrinsic" causes [4]. The common extrinsic factors that results in erosion of teeth are soft drinks, fruit juices, occupational habits like wine tasters, workers in battery industries. In the current times, consumption of soft drinks is very common among the people. Of these soft drinks, coca cola is commonly used [5,6].

The most common intrinsic factor that is seen in the patients is due to the various diseases and habits. In patients suffering with eating disorders like Gastroesophageal Reflux Disease (GERD), vomiting, regurgitation, bulimia nervosa there will be frequent vomiting of gastric juices [7]. The gastric juice is mainly composed of hydrochloric acid. In-vitro models are very important for providing insight into the fundamental mechanisms of biodegradation. During consumption, food or drink comes only in brief contact with tooth surfaces before it is washed away by saliva [8]. In the present study, hydrochloric acid was one of the tested solution, which is a main component in the gastric regurgitation, the common intrinsic factor for erosion [3].

The current study was designed to overcome the above mentioned limitation of in-vitro studies by employing a dynamic erosive pH-cycling model. Francisconi LF et al., has used this erosive pH cycling

Dependent variable			Mean difference (I-J)	Std. Error	p-value	95% Confidence interval: Lower bound	Upper bound
Control	FILTEK	CERAM	-12.6750	0.66	0.001*	-14.51	-10.84
		TETRIC	-16.8250	0.66	0.001*	-18.66	-14.99
	CERAM	FILTEK	12.67500	0.66	0.001*	10.84	14.51
		TETRIC	-4.15000	0.66	0.001*	-5.99	-2.31
	TETRIC	FILTEK	16.82500	0.66	0.001*	14.99	18.66
		CERAM	4.15000	0.66	0.001*	2.31	5.99
Cola	FILTEK	CERAM	-13.7750	0.94	0.001*	-16.39	-11.16
		TETRIC	-19.0750	0.94	0.001*	-21.69	-16.46
	CERAM	FILTEK	13.77500	0.94	0.001*	11.16	16.39
		TETRIC	-5.30000	0.94	0.001*	-7.92	-2.68
	TETRIC	FILTEK	19.07500	0.94	0.001*	16.46	21.69
		CERAM	5.30000	0.94	0.001*	2.68	7.92
HCl	FILTEK	CERAM	-13.1250	0.59	0.001*	-14.78	-11.47
		TETRIC	-17.8500	0.59	0.001*	-19.51	-16.19
	CERAM	FILTEK	13.12500	0.59	0.001*	11.47	14.78
		TETRIC	-4.72500	0.59	0.001*	-6.38	-3.07
	TETRIC	FILTEK	17.85000	0.59	0.001*	16.19	19.51
		CERAM	4.72500	0.59	0.001*	3.07	6.38

[Table/Fig-14]: Showing intergroup analysis of the three composites in three different solutions at six weeks time period Control=Artifical saliva.

model, where the samples were immersed in the tested solutions for five minutes, three times a day and kept in artificial saliva between the erosive cycles [9]. Between each immersion cycle, the samples should be immersed in artificial saliva with a gap of at least 4 hours. This is to simulate the buffering action and washing effect of saliva [3]. In the control group, artificial saliva was used as testing solution with pH 7.0. The samples were immersed in cola and HCl for five minutes, three times a day and the remaining time they were immersed in artificial saliva.

Various assessment techniques have been evaluated to assess the degradation of composite resin materials by erosive challenges which includes measurement of microhardness; surface roughness, weight changes, compressive strength, biaxial flexural strength, shear punch strength and wear [10]. Hardness or microhardness is often traditionally used as an indirect measurement of effectiveness of composite cure or the degree of conversion [11]. Microhardness measurements are not affected only by the degree of resin conversion, but also by the type and volume of filler percentage, storage conditions and the presence or absence of an oxygen inhibited layer [12].

In the present study, the discs of Filtek Z 350, Ceram X Mono and Tetric N Ceram were immersed in tested solutions for a period of day 1 and six weeks time interval. Vickers microhardness was tested on the three composites at the end of day 1 and six weeks. At the end of day 1 time period there was no significant difference in Filtek Z 350 when immersed in any of the testing solutions cola and HCL. This could possibly be explained by the increased monomer conversion and/or additional postcuring cross-linking reactions in the resin phase over the course of time [13,14].

There was a significant difference in surface microhardness of Ceram X Mono at day 1 time interval in cola and HCL solutions. The surface microhardness was significantly more in control group than cola and HCL group. But there was no significant difference between the tested solutions that is cola and HCL. This may be attributed to the difference in pH values of artificial saliva with cola and HCL.

There was a significant difference in surface microhardness of Tetric N Ceram at day 1 time interval in control and HCL solutions. The surface microhardness was significantly more in control group than HCL group. But there was no significant difference between the cola and HCL group. This may be attributed to the difference in pH values of artificial saliva with HCL.

Under acidic conditions, the acids present in the solutions promoted the release of unreacted monomers by penetrating into the resin matrix, there by resulting in decreased micro-hardness [15].

At one day time period there was a significant difference between all the three composites in the control group. In the control group (artificial saliva) the least microhardness was observed in Filtek Z 350. The microhardness values were higher in Ceram X Mono and Tetric N Ceram with the highest value.

In the cola group, at day 1 time period there was a significant difference between the microhardness of three composites with the highest microhardness in Tetric N Ceram and the least in Filtek Z 350. In the HCL group, at day 1 time period the highest microhardness was observed in Tetric N Ceram and the least microhardness was observed in Filtek Z 350. In the present study, the results showed that in all the three tested solutions, there was a significant difference of the surface microhardness between all the groups in all the solutions except for Filtek Z 350 and Ceram X Mono in HCL solution.

Briso AL et al., has explained that decrease in the surface microhardness of composite resins occur when immersed in organic acids was due to the softening of Bis-GMA in the resin polymers and leaching of the diluting agents such as TEGDMA [16]. Results of the previous studies have shown that when resin matrix consists of Bis-GMA and TEGDMA, it resulted in lower microhardness value because of the softening of Bis-GMA based polymers and leaching of TEGDMA diluents [7,17].

In all the three groups at six weeks time interval nanofilled (Filtek Z 350) showed least microhardness and nanohybrid (Tetric N Ceram) showed highest microhardness. There was significant decrease in microhardness values of Filtek Z 350, Ceram X Mono and Tetric N Ceram groups at day 1 and six weeks time interval in all the tested solutions i.e., artificial saliva, cola and HCL. This may be due to the hydrolysis of resin matrix due to absorption of liquid when immersed for about 6 weeks.

In cola group at day 1 and six weeks time interval there was significant decrease in surface microhardness for all the composites. Coca cola is a popular soft drink with low pH and this low pH had significant effect on hardness of restorative materials and has destructive effect on high strength restorative materials. This decrease in hardness was related to the Coca Cola, as it contains Phosphoric acid which behave as promoting dissolution and hence, eroding the materials [11].

In HCL group also there was significant decrease in surface microhardness for all the composites at day 1 and six weeks time interval. This may be due to the higher solubility in low pH solutions [18]. These study findings are in sync with the finding of the studies by authors, Poggio C et al., and Gupta R et al., [Table/Fig-15] [19,20].

Author's name and year	Place of study	Sample size	Materials used	Erosive solutions used	Parameter compared	Conclusion
Poggio C et al., 2018 [19]	Italy	30	1. Nanohybrid Ormocer-based Composite (Admira Fusion) 2. Ceram X Universal 3. Filtek Supreme XTE 4. Microfilled hybrid composite (Gradia Direct)	Acidic Solution (Coca Cola)	Microhardness	Filtek Supreme XTE and Admira Fusion showed less erosion by acidic solution when compared to Ceram X Universal. Gradia Direct showed lowest microhardness when compared to remaining solutions.
Gupta R et al., 2018 [20]	India	160	1. Nanocomposite Resin-Ceram X 2. Nano-ionomer (Ketac N 100) 3. Compomer-Compoglas F 4. Conventional composite Resin (Tetric -Econom)	Coca Cola Minute Maid Orange Juice Lemon Juice (Rasna) Fermented Milk (Yakult)	Microhardness	Ketac N 100 and Compoglas F showed more decrease in microhardness than Ceram X with acidic solutions. All the four resins showed negligible change in Yakult.
Present study	India	24	1. Filtek 2. Ceram X Mono 3. Tetric N Ceram	Artificial saliva Coca Cola HCl	Microhardness	Filtek showed more decrease in microhardness than Ceram X mono and Tetric N ceram.

[Table/Fig-15]: Comparison between similar studies.

Limitation(s)

This is a small study with a sample sample size. Few more studies with large sample size can be done for better accuracy.

CONCLUSION(S)

The composition of the resin component and pH of the solution immersed had an impact on surface microhardness. Nanohybrid composite resin materials (Ceram X Mono, Tetric N Ceram) resisted better surface degradation than nanofilled Filtek Z 350 composite resin. The decrease of surface microhardness was greater in low pH solutions of HCL and cola drink than in artificial saliva for all the three nanocomposite resin materials.

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