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Comparative Evaluation Of Surface Roughness Of Two Different Composite Resins Eroded By Acidic And Alcoholic Beverages : An in-vitro study.

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Abstract-
Background*: The purpose of this in-vitro study is to evaluate the effect of acidic and alcoholic beverages on the surface roughness of nanohybrid and nanofilled resin composite. 160 specimens were prepared and divided in to 4 equal groups based upon the composite material used. Group 1, Group 2, Group 3 and Group 4 containing 40 samples of each material . Specimens of each sample were immersed in Red wine, Orange juice, Cola drink and Deionized water (as a control group) respectively. Initial surface roughness were measured by profilometer. Then the samples were submitted to three cycles per day of exposure to acidic and alcoholic beverages for a period of 7 and 14 days. After immersion the samples in acidic and alcoholic beverages the surface roughness was analysed by* ***profilometer****. The data recorded was statistically analyzed using* ***one way ANOVA test followed by POST HOC TUKEYS TEST*** *at significant level of 0.05****. Post Hoc Tukeys test*** *was used for pair wise comparison of subgroups. A p- value of <0.05 or less was set for statistical significance (S). A p- values of >0.05 was set for statistical non-significant (NS). Nanofilled displayed the least surface roughness in all the tested groups. Whereas Nanohybrid showed the maximum surface roughenss.*

Key words: *composite resins, esthetic, surface roughness, profilometer.*

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I. Introduction

Esthetic dentistry has become one of the important part of dental practice that has grown in many years.[1] Dr Bowmen's invention of composite resin in 1940 has served to transform the field of modern esthetics dentistry.[2] The dental composite is defined as highly cross-linked polymeric materials reinforced by a dispersion of amorphous silica, glass, crystalline , mineral or organic resin filler particles and/or short fibers bonded to the matrix by a coupling agent (Phillips) . In an attempt to improve physical properties, the unfilled dental resins have undergone advancement from the conventional composites strengthened with strong filler particles to the relatively newer microfilled and hybrid composites.[3]

In oral environment, the surface of composites restorations are exposed to food and beverages with erosive substances along with the abrasive effect of tooth brushing and toothpastes. Therefore the aim of this in-vitro study is the comparative evaluation of the surface roughness of two different composite resin eroded by acidic and alcoholic beverages.

II. Materials and Methodology

Four resin composites and beverages were selected for this study: Esthet-X HD (Dentsply caulk,DE,USA) , Filtek Z350 (3M ESPE,st. paul, MN,USA) , Herculite (kerr corporation orange, CA 92867 USA), Tetric N-ceram (ivoclar vivadent) , Deionized water , Red wine , Coca-cola drink , Orange juice .

PREPARATION OF SAMPLES-

The materials tested were Esthet-X HD – high definition micro matrix restorative , Filtek Z350-nanofill restorative composite , Herculite précis enamel and Tetric N-ceram dental restorative. 40 specimens of each material were prepared by using a customized plastic circular mould (with internal dimension 3.5mm in diameter and 2mm in depth). Materials were manipulated according to the manufacture's instructions. The

mould with specimen material covered with a mylar strip on both sides was placed over glass slab and pressed between 2 glass slides to remove excess flash. The glass slide was pressed firmly during setting to avoid the presence of air bubbles and to obtain a smooth surface. These materials were polymerized by LED light curing unit using 40 second exposure to each specimen's top and bottom surface. The distance between the light source and specimen was standardized by placing the curing light directly over the specimen. The light intensity of the curing light was checked regularly with the radiometer during specimen preparation which was constant at 700 mw /cm^2. To ensure complete polymerization and rehydration, the samples were stored in deionised water for 24 hours at room temperature. The top surface of all the specimens were the sequentially polished with coarse followed by medium, fine, and super – fine 3 M polishing disc with slow speed hand piece under dry condition.

THE pH MEASUREMENTS -
Alcoholic beverage, fruit juice, soft drink and deionized water were used in this study. The pH of each specimen was determined by pH meter. Ten pH readings of each beverages were obtained so as to give a mean pH measurement.
pH of red wine - 3
pH of orange juice- 2.8
pH of cola drink- 2.5
pH of deionized water- 6.8

Grouping of samples-(Based on beverages used)			
Group 1alcholic drink	**Group 2 fruit juice**	**Group 3 soft drink**	**Group 4 deionized water**
Subgroup A Herculite	Subgroup A Herculite	Subgroup A Herculite	Subgroup A Herculite
Subgroup B Tetric - -N- ceram	Subgroup B Tetric - -N- ceram	Subgroup B Tetric - -N- ceram	Subgroup B Tetric – -N- ceram
Subgroup C Filtek Z350	Subgroup C Filtek Z350	Subgroup C Filtek Z350	Subgroup C Filtek Z350
Subgroup D Esthet-X HD	Subgroup D Esthet-X HD	Subgroup D Esthet-X HD	Subgroup D Esthet-X HD

40 specimens of each sample were immersed in Red wine, Orange juice, Cola drink and Deionized water (as a control group) respectively. Each group was evaluated for surface roughness measurement for baseline data (before immersion). The specimens were alternatively immersed for 25 minutes in 25 ml of a storage agent and for 5 minutes in 25ml of artificial saliva. This procedure was conducted over four cycles at room temperature. After the cyclic immersion, specimens were immersed in artificial saliva (change daily) and kept overnight at 37°C. This process was repeated for 5 days following immersion in artificial saliva for 2 days (1trips). After immersion, specimens were evaluated for surface roughness (on day 7 for 1 trip and day 14 for 2 trips). To maintain the original pH level of the storage agents, immersion media was changed daily throughout the experiment. After the immersion, sequence was completed, the specimens were rinsed with deionized water.

TESTING OF SAMPLES - The samples were then air dried and subjected to a surface roughness test with a contact stylus surface profilometer with a measuring speed 0.75mm/s (0.3inch/s) and the tip 4mN type stylus, which having a 4mN/5µR 90º force to get surface roughness value (Ra).Three value were measured and mean was calculated.
Statistical analysis- Statistical analysis was performed by means of **one way ANOVA test** followed by **POST HOC TUKEYS TEST** at significant level of 0.05. Post Hoc Tukeys test was used for pair wise comparison of subgroups.

III. Results

Comparison of mean surface roughness of tested composite in different beverages.

MATERIALS	**BEVERAGES**
Herculite précis enamel	Orange juice<deionized water<wine <cola
Tetric N-ceram	Deionized water<cola<orange juice<wine
Filtek Z350	Deionized water<wine<orange juice<wine
Esthet-X HD	Deionized water<orange juice<wine < cola

Comparison of mean surface roughness (Ra) of composite in different beverages

BEVERAGES	MATERIALS
Red wine	Filtek Z 350<esthet-HD<herculite<tetric-N-ceram
Orange juice	Esthet–HD<filtekZ350 <herculite<tetric-N-ceram
Coca-cola	Esthet–HD<filtekZ350<tetric-N-ceram<herculite
Deionized water	Filtek Z350<Esthet –HD<herculite<tetric –N-ceram.

Smoothest surface was observed in control group for Filtek Z350, Esthet-HD and Herculite.Tetric-N-ceram and Herculite displayed the roughest surface in coca-cola while Filtek Z350 and Esthet –HD displayed the smooth surface in Deionized water.

Table1 : Over all comparison of surface roughness of all composite after immersion in different beverages.

		GROUP 1	GROUP 2	GROUP 3	GROUP 4	ONE WAY ANOVA
DAYS	SUBGROUP	MEAN	MEAN	MEAN	MEAN	
BASELINE	A	.68	.46	.48	.68	.270
7 DAYS	A	.68	.51	.68	0.68	0.471
14 DAYS	A	.86	.55	2.69	.68	0.031*
BASELINE	B	.79	.87	.66	.79	0.647
7 DAYS	B	1.54	1.03	.82	.79	0.080
14 DAYS	B	2.33	1.12	.92	.79	0.002*
BASELINE	C	.20	.17	.20	.20	0.617
7 DAYS	C	.25	.21	.27	.20	0.015*
14 DAYS	C	.28	.35	.43	.20	0.002*
BASELINE	D	.24	.23	.22	.30	0.480
7 DAYS	D	.27	.28	.28	.29	0.990
14 DAYS	D	.28	.35	.43	.20	0.00*

IV. Discussion

The composite resins chosen in this study are differ in their filler content and matrix completely. This help to determine the effect of beverages over wide range filler particles and resin matrix in these newer formulation. In the present study four different composite were used i.e. **- Esthet-X HD, Filtek Z350, Herculite and Tetric –N- Ceram.**

Subgroup	Materials	Composition	Filler wt%(vol.%)	Lot no.
A	Herculite	Bis-EMA, UDMA, TEGDMA **Filler:** Prepolymerized filler, barium glass. **Average particle size** Prepolymerized filler, barium glass filler 0.4.	84 (wt%)	211135
B	Tetric- N-ceram	Matrix: Bis-GMA, UDMA, TEGDMA, Bis-EMA resins Filler: a)Barium glass, ytterbium trifluoride, mixed oxide, silicon dioxide b) Prepolymers c) Nanofillers	80.5(wt%)	244552
C	Filtek Z350	Matrix: Bis-EMA, UDMA, TEGDMA, Bis- GMA Filler: a combination of zirconia and silica cluster nanofiller	78.5(wt%)	20070628
D	Esthet-X HD	Maxtrix: Bis –GMA, BIS-EMA,TEGDMA Filler:barium fluoroborrosilicate glass with a mean particle size less than 1μm and nanofiller silica (particle size 0.04μm).	57.5(wt%)	141208

Despite the development in the composition and characteristics of these restorative materials, these composite restorations in the oral cavity are exposed to a certain number of conditions that may initiate changes in physical and mechanical properties of these restoration, such as color, surface roughness and hardness.[4] **Penteado RAPM et al (2010)** observed that the nanofilled and microhybrid composites showed a significant increase in the surface roughness after toothbrushing and pH-cycling.[5]

Khlaid AL-Samadani (2013) Assessed the erosive potential of red bull, Bison, power horse and distilled water on surface roughness of nanofilled and nanohybrid composite. He observed the surface roughness parameter of resin composite depending on the type of solution and its capacity.[6]

Beverages used in this study were coca-cola, orange juice, red wine and deionized water. These beverages had been used because now people have changed their dietary habits, which are associated with excessive consumption of energy drinks, soft drinks (orange juice, and cola) and alcoholic drinks (whisky, red wine etc.) that may lead to erosion of resin composite and tooth surface. The surface degradation of resin materials is associated to the content and distribution of the fillers.

Soft drinks contain citric acid, phosphoric acid and carbonic acid for refreshing. The pH of drinks can be as low as 2.6 which can cause erosion leading to surface roughness. While preparing, primarily the pH of wine is around 3.0 and after completion of preparation, pH ranges from 3.3 to 3.8. The main acid components are malice and tartaric acids, along with a combined concentration of 5-8g/l lactic acid, together with small amounts of citric and succinic acids.[7]

Group	Beverage	Trade name	Composition	pH
1	Red wine	Ag forty seven	Merlot(65%), cabernet sauvignon(20%),cabernet france(15%)	3
2	Orange juice	Coca–cola company	Carbohydrate, proteins, vitamins, minerals, citric acid, water	2.8
3	Coc-COLA	Coca-cola company	Carbonated water, sugar, extract of cola nuts, caffeine, caramel color, acidulante INS338, carbohydrates and sodium	2.5
4	Deionized water	Nice chemical	Chloride, sulphate, iron, heavy metalNitrate,ammonium, phosohate, aluminium, Calcium and magnisum, silicate, sodium and potassium	4

Previous studies have demonstrated the presence of superficial changes seen on dental composites caused by some food- stimulating liquids and acidic beverages. This alteration has been attributed to the polymer matrix and resin- filler interface degradation along with the loss of inorganic filler particles.[8]

Agarwal S et al (2011) Evaluated the effect of cola on the microhybrid composite after 60 days immersion period, they observed the surface roughness had rapidly increased after one week.[9] **Bajwa NK and Pathak A (2014)** compared the effect of different immersion regimens on surface roughness of esthetic restorative materials.[10]

Time period of 7 days and 14 days was finalized because it was considered as the surface roughness is linked to the material composition and pH of beverages.

The specimen were immersed for 5 min. in artificial saliva to stimulate oral condition In a study **Badra et al (2005)** reported that within 7 days there was significant increase in surface roughness which was later decreased when evaluated after 30 and 60 days.[11]

Tanthanuch S and Kukiattrakoon B. (2016) reported that red and white wine significantly, decrease the surface hardness of nanocomposite, particularly at the end of 14 days after immersion period.[12]

Esthet XHD show highest surface roughness after immersion in red wine then in coca cola and then in orange juice; Least surface roughness is seen in deionized water. From the result of our study showed that filtek Z350 displayed the least surface roughness among all the tested composite after immersion in different beverages. The possible reason for lesser surface roughness of filtek Z350 could be higher filler loading of 78.5% weight. Limitation of the study could be the complex environment of the oral cavity could not exactly and entirely replicated by in-vitro experimental studies. Although the present study confirmed that coca-cola and red wine had a detrimental effect on the surface roughness of composite and hence lifespan of composite resin material.

V. Conclusion

Within the limitation of present study it can be concluded that Resin composites showed different surface roughness values, depending on their composition, filler types and polymerization method.

The maximum surface roughness was seen in subgroup B (Tetric –N- Ceram), followed by subgroup A (Herculite), followed subgroup D (Esthet X HD) and least was seen in subgroup C (Filtek Z350). Both intergroup and intragroup comparison suggested that there is a change in surface roughness in resin based composites over a period of 7 and 14 days.

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