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Evaluation of the effect of acidic drinks on the microhardness of different Esthetic restorative materials

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Abstract

Introduction: Increased demand for Esthetic resto rations has resulted in a paradigm shift in dental practice. With the increasing consumption of aerated soft drinks and beverages, the impact on the longevity of the restorations needs to be assessed.

Methodology: The 24 samples of each group were subdivided into 3 groups each containing n=8 samples based on exposure to acidic beverage – no exposure, 1 day and 7 days respectively: group 1- Polo fil NHT, Group 2 – Omni Chroma, Group 3 - Neo Spectra ST. The samples were tested for surface microhardness before and after exposure.

Results: The maximum and minimum surface microhardness values were noted in the Polo fil NHT group and Neo spectra ST Groups respectively when kept in artificial saliva, acidic medium for 1 day, and in an acidic medium for 7 days respectively with the difference among them being statistically significant.

Conclusion: Within the confines of the current study, Polo fil NHT shows the best performance on exposure to acidic beverages as compared to Omni Chroma and Neo Spectra ST.

Keywords: Microhardness, Composite resin, Acidic beverages, Nanohybrid materials, Polo fil NHT, Omni Chroma, Neo Spectra ST, Restorative dentistry

Introduction

In the modern era, increased ask for Esthetic restorations have resulted in the evolution of materials. Composite resins remain the material of choice for direct restorations, chiefly owing to their Esthetic performance, minimally invasive preparation, ease of handling, and affordability. The ongoing quest for the ultimate Esthetic restorative material has encouraged significant evolution aiming to improve the clinical performance of restorative materials.[1]Among the most significant properties determining the longevity of resto rative materials in oral environ ments is resistance to degenerative dis integration.[2]

In the oral cavity, the restorations are subjected to continuous or intermittent degradation, which can be attributed to a complex interaction between mechanical wear as well as a chemical phenomenon. Chemical degradation can occur due to both microbial and non-microbial etiologies. The former results from a step-wise biofilm formation, whereas the latter occurs as a result of dental erosion originating from extrinsic or intrinsic causes. Under either circumstance, there is a reduction of pH less than the critical level of 5.5 which alters the oral environment and negatively impacts the tooth and restorative surfaces.[2, 3, 4]

Literature suggests statistically significant associations between the prevalence of altered surface characteristics of Esthetic materials and consumption of acidic beverages.[1, 2, 3, 4, 5, 6]

Therefore the current research was undertaken to gauge the impact of acidic beverages on the alteration in microhardness of three diverse Esthetic restorative resin-based materials – Polo fil NHT (Voco), Omni Chroma (Tokuyama Dental America) and Neo Spectra ST (Dentsply).

Methodology

The three composite resins used were – Polo fil NHT (Voco), Omni Chroma (Tokuyama Dental America) and Neo spectra ST (Dentsply). The sample size was calculated using data of analogous studies, and an adequate sample proportion was derived as a total of 72 samples where the number of samples in each group was n=24 based on the three materials.

Sample preparation

The composite resin material was inserted and slightly over-filled into a mould of set dimensions, i. e. 10mm diameter and 1mm thickness. The surfaces were shielded using Mylar strips and were then pressed flat with the help of a glass slide to extrude surplus material and obtain an evenly smooth surface. A 1200 mW/cm^2 intensity light-emitting diode (LED) light (Blue phase, Ivoclar Vivadent AG) was utilized for polymerization of the materials for 20 seconds. The tip was held abutting the glass slide at right angles to standardize the curing uniformly at a tip distance of 1mm from the material surface, while the standardization of light intensity was ensured using a radiometer. The exposed surface of all samples was polished using polishing disks (Sof-Lex Pop on; 3M ESPE, St. Paul, MN, USA) to best mimic the clinical situation. All light-cured samples were kept in distilled water at 37°C for 24 hours in a dark atmosphere to ensure thorough polymerization.

Sample testing

The 24 samples of each group were subdivided into 3 groups each containing n=8 samples based on exposure to the acidic beverage. The samples were blot-dried completely using tissue paper and were subjected to measurement of baseline surface microhardness just before immersion with the help of a Vickers diamond indenter. All the samples of subgroups 1A, 2A and 3A were immersed in artificial saliva and were identified as

controls. All the other samples were immersed in 25mL of an acidic beverage (Coca-Cola, Coca-Cola Company) maintained at room temperature for 10 minutes each day for 1 day and 7 days respectively. At the end of the acidic exposure, the samples were subjected to Vicker's Microhardness test.

Group 1 (Polo fil NHT)	Subgroup 1A (n=8)	Artificial saliva (CTR)
	Subgroup 1B (n=8)	1-Day in acidic medium
	Subgroup 1C (n=8)	7-Day in acidic medium
Group 2 (omni Chroma)	Subgroup 2A (n=8)	Artificial saliva (CTR)
	Subgroup 2B (n=8)	1-Day in acidic medium
	Subgroup 2C (n=8)	7-Day in acidic medium
Group 3 (neo spectra st)	Subgroup 3A (n=8)	Artificial saliva (CTR)
	Subgroup 3B (n=8)	1-Day in acidic medium
	Subgroup 3C (n=8)	7-Day in acidic medium

The micro-hardness reading was measured using an average of three consecutive readings at a force of 100 g for 15 seconds. The values obtained were then statistically analysed.

Results

The data was compiled and subjected to statistical investigation using SPSS Statistics software. Results on continuous measurement are illustrated as Mean and standard deviation (SD).

Inferential statistics Kruskal Wallis was utilized to evaluate the three groups (Table 1). Comparative evaluation among groups was accomplished using the Mann-Whitney U test where $p<0.05$ was taken to be significant statistically. (Table 2)

The highest and lowest surface microhardness values were noted in the Polo fil NHT group and Neo spectra ST group respectively when stored in artificial saliva, in an acidic medium for 1 day and acidic beverage for 7 days with the difference among them being statistically significant. (Graph 1)

The difference among all three groups was significant statistically except for the evaluation between the Omni Chroma group and Neo spectra ST group in acidic beverages for both 1 and 7 days.

Tables and graphs

Table 1: Kruskal-Wallis test demonstrating the overall comparison among groups

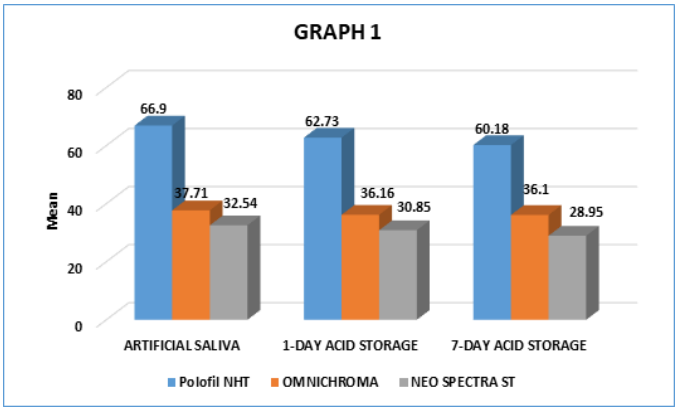
Groups	Artificial saliva (Group A) (Mean±SD)	1-Day in acidic medium (Group B) (Mean±SD)	7-Day in acidic medium (Group C) (Mean±SD)
Group 1 (Polo fil NHT)	66.9±4.42	62.73±2.41	60.18±3.85
Group 2 (omni-Chroma)	37.71±1.59	36.16±1.94	36.10±3.04
Group 3 (Neo Spectra ST)	32.54±2.05	30.85±3.35	28.95±4.07

Table 2: Mann-Whitney U test demonstrating inter-group comparison.

Group	Artificial saliva (group a)	1-day acid storage (group b)	7-day acid storage (group c)
(Polo fil NHT) - (Omni Chroma)	0.001*	0.001*	0.001*

(Polo fil NHT)- (Neo Spectra ST)	0.001*	0.001*	0.001*
(Omni Chroma)- (Neo Spectra ST)	0.001*	0.003	0.002

Graph 1: Comparison between surface microhardness values among groups



Discussion

Surface irregularities render the restorations vulnerable to the accumulation of dental plaque, resulting in gingivitis and periodontal diseases. Furthermore, staining resulting from these circumstances causes restoration failure and unaesthetic appearance thereby affecting the longevity of restorations. Hence a thorough understanding of the material properties will aid in decision-making and treatment planning to achieve the best results.[8, 9]

Coca-Cola drink was the acidic beverage of choice for this study as it has a decreased pH and decreased calcium and fluoride concentrations which help simulate high-risk conditions. The immersion time was chosen as 5 minutes based on evidence suggesting that the pH of saliva reverted to baseline 1-3 minutes following a solitary sip of an acidic drink.[10] According to research data the greatest variation in hardness of composite materials occurred within the first week of the experiment and therefore the post-exposure measure Ment of micro hardness in the present study was done at 7 days.[9] Based on the results, it is observed that samples of all three materials showed changes on exposure to acidic beverages and the reduction in microhardness was statistically significant.

Reduced surface microhardness of composite resins exposed to acidic environments as a result of softening of the bisphenol-A-glycidyl methacrylate (Bis-GMA)-based polymer component, resulting from diluent agents like tri-ethylene glycol Di methacrylate (TEG DMA) leaching out of the matrix. Additionally, destruction at the matrix/filler interface also contributes to the failure of the restoration.[6, 9]

Since the dawn of nanotechnology, which functions within a range of 0.1–100 nm, the research efforts in the resin-based composite materials arena have been directed towards nano-filler and nano-hybrid comple ments. A nano-hybrid refers to a hybrid resin composite consisting of nano-fillers in a filler form where particles are pre-polymerized, whereas nano-filled refers to a composite resin consisting of a combination of nanomers and nanoclusters. These nano-materials are expected to deliver improved material properties to ensure clinical longevity and durability of the restoration in the oral cavity.[7, 11, 12, 13] In the present study, Polo fil NHT, a nanohybrid composite, is compared with Neo Spectra ST and Omni Chroma, a universal nano-ceramic composite and a universal super-nano-filled composite respectively. To the best of our information, the three types of materials chosen for the present study have never been compared with each other.

Vickers microhardness test was chosen as it is a consistently straight forward method for indirect assessment of the degree of poly merization. Moreover, it is indicative of the rigidity of the material which translates to the resin's mechanical strength.[1, 2, 4, 5] Based on the observed results, the highest micro hardness

values were demonstrated by Polo fil NHT followed by Omni Chroma and the least microhardness was exhibited by Neo Spectra ST.

In the present study, Polo fil NHT demonstrated the highest surface microhardness and the least reduction in surface microhardness. The resin matrix of Polo fil NHT consists of evenly embedded nano-particles which exhibit better mechanical, chemical and optical pro perties. Owing to the combination of nano-particles with glass ceramic fillers of a matched particle size range; the total filler content in Polo fil NHT exceeds 83 % w/w, ensuring high flexural and compressive strengths. Additionally, the nano-particles impart liquid-like behaviour, all of which results in a smoother surface with increased microhardness and micro abrasion resistance.[13, 14, 15]thereby substantiating its merits.

Omni Chroma is a universal, supra-nano-filled dental composite that contains only spherical fillers in the quantity of 82% by weight or 71% by volume which is expected to translate into increased esthetics and high wear resistance. It consists of 'Est elite' technology which is unique as it allows for a flexible shade-matching process, which indicates that a single composite is suitable for any shade of substrate.

In the current study, the surface microhardness of the Omni Chroma group was less than the Polo fil NHT group, which was followed by the Neo Spectra ST group with a statistically significant difference among them when stored in artificial saliva. On being exposed to acidic beverages for 1 and 7 days, Polo fil NHT outperformed other materials and the difference was statistically significant; but, Omni Chroma and Neo Spectra ST demonstrated similar results on acid exposure at both 1 and 7 days.

Neo Spectra ST has been described by the manufacturer as a nano-ceramic composite. It consists of novel Sphere TEC filler technology which contains sub-micron granulated glass spherical fillers in combination with a resin matrix system, which can bind more free resin compared to usual fillers. According to the manufacturer, it is recommended for both anterior and posterior restorations while being equally efficient for both direct and indirect procedures. [15, 16, 17, 18]

Among the three materials, the highest surface microhardness was noted for Polo fil NHT, followed by Omni Chroma and the least microhardness was demonstrated by Neo Spectra ST composite. These differences can be attributed to the filler content and size of fillers of the three materials. The highest filler content present in Polo fil NHT along with the nano-hybrid size of fillers ensures the highest wear resistance while enabling a smoother surface after polishing.

Conclusion

Exposure to acidic beverages results in adverse effects on composite restorations. In the present study, Polo fil NHT demonstrated the best performance as compared to Omni Chroma and Neo Spectra ST. This study's results may discretely be applied to clinical scenarios to aid in decision-making for Esthetic restorations.

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