The Impact of Acidic Beverages on The Microhardness of Various Esthetic Dental Restorative Materials

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ABSTRACT

Introduction: An increase in the demand for aesthetic restorative procedures has brought about a shift in the dental practice paradigm. It is necessary to assess the impact of the consumption of carbonated soft drinks and other beverages on the longevity of restorations.

Materials and Method: The 48 samples from each group were divided into three subgroups based on the duration of exposure to acidic beverages (no exposure, 1 day, and 7 days). These subgroups were: Group 1- Polo fil NHT, Group 2- Omni Chroma, and Group 3- Neo Spectra ST. The surface microhardness of the materials was evaluated before and after exposure.

Results: The study found that the Polo fil NHT group and the Neo Spectra ST group had the highest and lowest surface microhardness values, respectively, after exposure to an acidic medium for one day and seven days in artificial saliva. The difference between these values was statistically significant. Based on the study's parameters, Polo fil NHT was found to perform better than Omni Chroma and Neo Spectra ST when exposed to acidic beverages.

Conclusion: Polo fil NHT was the most resistant to the effects of acidic beverages among the tested materials.

Keywords: Nanohybrid materials, Polo fil NHT, Omni Chroma, Neo Spectra ST, Microhardness, Acidic beverages.

INTRODUCTION

The demand for aesthetic restorations has grown significantly in the modern period, which has led to material evolution. For direct restorations, composite resins continue to be the material of choice, primarily because of their aesthetic efficacy, slightly invasive preparation, simplicity of use, and affordability. Significant development aimed at enhancing the clinical performance of restorative materials has been sparked by the never-ending search for the ideal Esthetic restorative material.[1]Resistance to degenerative disintegration is one of the most important factors affecting the life of restorative materials in oral environments.[2]

The degradation of the restorations in the oral cavity, which can be ascribed to a complex interaction between mechanical wear and a chemical phenomenon, can be continuous or intermittent. Both bacteria and non-microbial aetiologies can cause chemical degradation. The former is caused by the step-by-step development of a biofilm, whereas the latter is brought on by dental erosion that has intrinsic or extrinsic causes. In either case, the pH is

reduced below the crucial 5.5 threshold, which alters the oral environment and has a detrimental effect on the tooth and restorative surfaces.[2- 4]
The prevalence of altered surface features of aesthetic materials and consumption of acidic drinks are statistically associated, according to the literature.[1-6]
The goal of the present study was to compare how three different aesthetic restorative resin-based materials, Polo fil NHT (Voco), Omni Chroma (Tokuyama Dental America), and Neo Spectra ST, changed in terms of their microhardness when exposed to acidic beverages. (Dentsply).

MATERIALS AND METHOD

Three composite resins, namely Polo fil NHT (Voco), Omni Chroma (Tokuyama Dental America), and Neo spectra ST (Dentsply), were utilized in the study. The sample size was determined based on similar studies, and a total of 144 samples were deemed sufficient, with 48 samples for each of the three materials.
To prepare the samples, the composite resin material was injected into a mold with set dimensions of 10mm diameter and 1mm thickness, slightly overfilling it. The surfaces were covered with Mylar strips and pressed flat using a glass slide to remove excess material and achieve a smooth and even surface. Polymerization was done using a 1200 mW/cm2 intensity LED light (Blue phase, Ivoclar Vivadent AG) for 20 seconds. The tip of the LED light was held perpendicular to the glass slide and kept at a distance of 1mm from the material surface to ensure uniform curing. Light intensity was standardized using a radiometer. The exposed surface of all samples was polished with Sof-Lex Pop on polishing disks (3M ESPE, St. Paul, MN, USA) to simulate a clinical situation. To ensure complete polymerization, all light-cured samples were stored in distilled water at 37°C in a dark environment for 24 hours.
The samples from each group, n=48, were further divided into three subgroups of n=8 based on the duration of exposure to an acidic beverage. Prior to immersion, the baseline surface microhardness of all samples was measured using a Vickers diamond indenter. The first subgroup (1A), second subgroup (2A), and third subgroup (3A) served as controls and were immersed in artificial saliva. The remaining samples were immersed in 25mL of cola flavoured carbonated soft drink, an acidic beverage maintained at room temperature, for 10 minutes per day for 1 day and 7 days, respectively. (Table 1) After the completion of the acidic exposure, Vickers Microhardness tests were conducted on the samples. The micro-hardness reading was measured by averaging three consecutive readings at a force of 100 g for 15 seconds. Finally, the obtained values were subjected to statistical analysis.

Group 1 Polo fil NHT (Voco)	Subgroup 1A (n=16)	Artificial Saliva (control)
	Subgroup 2B (n=16)	1 day in acidic beverage
	Subgroup 3C (n=16)	7 day in acidic beverage
Group 2 Omni Chroma (Tokuyama Dental America)	Subgroup 1A (n=16)	Artificial Saliva (control)
	Subgroup 2B (n=16)	1 day in acidic beverage
	Subgroup 3C (n=16)	7 day in acidic beverage
Group 3 Neo spectra ST (Dentsply)	Subgroup 1A(n=16)	Artificial Saliva (control)
	Subgroup 2B (n=16)	1 day in acidic beverage
	Subgroup 3C (n=16)	7 day in acidic beverage

Table 1: Sample Distribution

RESULTS

The Mean and standard deviation (SD) were used to represent results on continuous measurement in the study. The collected data was analyzed using SPSS Statistics software, and inferential statistics Kruskal Wallis was applied to assess the three groups (Table 2). The

Mann-Whitney U test was used for comparative analysis between the groups, with $p<0.05$ considered statistically significant (Table 3).

In terms of surface microhardness, the Polo fil NHT group showed the highest values while the Neo spectra ST group demonstrated the lowest values when stored in artificial saliva, acidic medium for 1 day, and acidic beverage for 7 days, with a statistically significant difference between them. Furthermore, there was a statistically significant difference among all three groups, except for the comparison between the Omni Chroma group and Neo spectra ST group when exposed to acidic beverages for both 1 and 7 days (Table 2 and 3).

Groups	Subgroup A (control) Mean±SD	Subgroup B (test group- 1 day) Mean±SD	Subgroup C (test group- 7 day) Mean±SD
Group 1 (Polo fil NHT)	65.8±3.42	62.37±2.52	61.15±3.85
Group 2 (Omni Chroma)	36.81±1.44	36.56±1.84	35.90±3.14
Group 3 (Neo spectra ST)	33.05±1.69	31.05±3.07	29.11±4.35

Table 2: Overall comparison among groups with Kruskal- Wallis Test

Groups	Subgroup A (control)	Subgroup B (test group- 1 day)	Subgroup C (test group- 7 day)
Group 1 vs Group 2	0.001*	0.001*	0.001*
Group 1 vs Group 3	0.001*	0.001*	0.001*
Group 2 vs Group 3	0.003*	0.06	0.03

Table 3: Intergroup comparison among groups with Mann-Whitney U Test ($p<0.05$)

DISCUSSION

Gingivitis and periodontal diseases are brought on by the build-up of dental plaque on restorations because of surface irregularities. Additionally, the staining brought on by these conditions shortens the lifespan of restorations and impairs their aesthetic appearance. Therefore, to make the best decisions and plan the best course of treatment, it is important to have a comprehensive knowledge of the material properties.[7, 8]

Since cola flavoured carbonated soft drink usually has a lower pH and lower calcium and fluoride concentrations than other acidic beverages, which help to mimic high-risk conditions, it was chosen for this research as the acidic beverage of choice. Based on data indicating that the pH of saliva returned to baseline 1-3 minutes after taking a single sip of an acidic beverage, the immersion time was set at 5 minutes.[9] The post-exposure measure was chosen because, according to research data, the first week of the experiment saw the largest variation in the hardness of composite materials. In the current research, measurement of microhardness was done after 7 days.[8] According to the findings, samples of all three materials exhibited changes after being exposed to acidic drinks, and the decrease in microhardness was statistically meaningful.

Reduced surface microhardness of composite resins in acidic environments due to softening of the bisphenol-A-glycidyl methacrylate (Bis-GMA)-based polymer component as a result of diluent agents like tri-ethylene glycol di methacrylate (TEG DMA) seeping out of the matrix. The loss of the restoration is also attributed to damage at the matrix/filler interface.[6,8]

Research efforts in the field of resin-based composite materials have been focused on nano-filler and nano-hybrid completions since the advent of nanotechnology, which operates within a range of 0.1-100 nm. A nano-filled resin is a composite resin made of a mix of nanomers and nanoclusters, whereas a nano-hybrid resin is a hybrid resin composite made of nano-fillers in a filler form where particles are pre-polymerized. Improvements in material properties are anticipated from these nanomaterials to guarantee the therapeutic viability and endurance of the restoration in the oral cavity.[10-13] In this research, Neo Spectra ST, a universal nano-ceramic composite, and Omni Chroma, a universal super-nano-filled composite, are contrasted with Polo fil NHT, a nanohybrid composite. To the best of our knowledge, no comparisons between the three types of materials used in the current research have ever been made.

Vickers microhardness test was selected because it is a reliable, simple method for determining the degree of indirect polymerization. Additionally, it is a sign of the material's rigidity, which correlates to the mechanical strength of the resin.[1, 2, 4, 5] Based on the findings, Polo Fil NHT and Omni Chroma showed the highest micro hardness values, while Neo Spectra ST showed the lowest micro hardness values.

Polo fil NHT showed the highest surface microhardness and the least amount of surface microhardness reduction in the current research. Polo fil NHT's resin matrix contains equally distributed nanoparticles with improved mechanical, chemical, and optical properties. Due to the combination of glass ceramic fillers with nanoparticles of a matched range of particle sizes, Polo fil NHT has a total filler content that surpasses 83% weight for high flexural and compressive strengths. The addition of liquid-like behaviour and enhanced microhardness and micro abrasion resistance from the nano-particles also produces a smoother surface thereby supporting its benefits. [13-15.]

Omni Chroma is a dental composite that is filled with supra-nano spherical fillers, comprising 82% by weight or 71% by volume, aimed at increasing wear resistance and esthetics. It is a universal composite featuring "Est elite" technology, which enables the material to match any shade of substrate, providing flexibility in the shade-matching process.

In the present investigation, the surface microhardness of the Omni Chroma group was statistically significantly lower than that of the Polo fil NHT group and higher than that of the Neo Spectra ST group when stored in artificial saliva. Polo fil NHT was superior to the other materials when exposed to acidic beverages for 1 and 7 days, and the difference was statistically significant. However, in terms of acid exposure for both 1 and 7 days, Omni Chroma and Neo Spectra ST exhibited comparable outcomes.

The manufacturers of Neo Spectra ST refer to it as a nano-ceramic composite. It is made up of the novel Sphere TEC filler technology, which combines a resin matrix system with sub-micron granulated glass spherical fillers to bond more free resin than conventional fillers. The maker claims that it is equally effective for both direct and indirect procedures, and is advised for anterior and posterior restorations. [15- 18]

The surface microhardness of the three composite materials was compared, and it was observed that Polo fil NHT exhibited the highest microhardness, followed by Omni Chroma, and Neo Spectra ST had the least microhardness. The variation in microhardness could be attributed to the amount and size of the fillers in each composite material. Polo fil NHT had the highest filler content and a nano-hybrid filler size, resulting in excellent wear resistance and a smooth surface after polishing.

CONCLUSION

The harmful impact of acidic beverages on composite restorations has been well documented. However, the findings of the current study suggest that among the tested materials, Polo fil NHT exhibited the most favorable performance, followed by Omni Chroma and Neo Spectra

ST. The results of this study could be useful in clinical settings for making informed decisions regarding esthetic restorations.

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