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Effect of Ddifferent Acidic Beverages on Microhardness of Nanohybrid Composite and Fibre Reinforced Composite – An In Vitro Study

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Abstract

AIM: This study was aimed to evaluate effects of various beverages on micro hardness of aesthetic restorative materials like nanohybrid and fibre reinforced composite.

Materials and methods: 28 disk-shaped specimens (07 mm in diameter and 2 mm thickness) were made from each nanohybrid and fibre reinforced composite. The specimens were dipped in distilled water, Appy fizz, Mirinda orange, and seven Up for 50 seconds and washed with saline. This cycle was continued for six times each day. All specimens were stored in artificial saliva during study. Vickers microhardness test was carried out in regular intervals, that is, 7, 14, and 21 days. Statistical analysis - Data were analyzed by one-way analysis of variance followed by Tukeys post hoc test.

Results: There was reduction in hardness after 7 and 14 days but no significant difference ($P > 0.05$). There was significant difference after 21 days of experimental models for both the composites.

Conclusion: Microhardness reduced significantly after 21 days of immersion in Mirinda orange followed by Seven Up and Appy fizz and Fiber reinforced composite has superior resistance to degradation as compared to nanohybrid composite resins.

Keywords: Acidic beverages, nanohybrid, fibre reinforced, microhardness.

Introduction

The concept of health has prevailed for centuries and dietary habits are apparently changing with modernization. It has been reported that contemporary fluid consumption patterns of children are now more diverse than in past years, since carbonated soft drinks and fruit juices have replaced much of the previous consumption of water and milk among children[1]. Excessive contact of the tooth structure with acidic food leads to loss of dental hard tissues. Thus it can be assumed that restorative materials, when subjected to low pH environment in the oral cavity, leads to degradation of its surface and marginal integrity[2]. One factor, which has an appreciable influence on the satisfactory clinical performance of dental restorations, is their resistance to biodegradation. In the oral cavity, this process includes diverse phenomena, such as sliding, abrasion, chemical degradation, and fatigue[3]. Degradation of restorative materials cannot be attributed to wear alone, but involves chemical degradation as well. In vivo, these materials may either be exposed intermittently or continuously to chemical agents found in saliva, food, and beverages. Intermittent exposure occurs during eating or drinking beverages and juices until teeth are cleaned. Continuous exposure may, however, occur as chemical agents can be absorbed by different debris (such as calculus or food particles) at the margins of restorations or be produced by bacterial decomposition of debris.[4]

To be clinically successful, restorative materials are required to have long-term longevity, a quality which is strongly influenced by not only the intrinsic characteristics but also by the environment to which they are exposed to [6,7,8]. Oral cavity is a complex, aqueous environment where the restorative material is in contact with saliva. In addition, other factors such as low pH due to acidic foods and drinks may influence the materials physical and mechanical characteristics[9]. However, "under in vivo conditions, composite resin materials may be exposed either discontinuously or continually to chemical agents found in saliva, food, and beverages[5]. Consequently, in the short- or long-term, these conditions may have a deleterious effect on the polymeric network, modifying its structure physically and chemically[10]. The mechanical property of the dental composites largely depends on concentration of the filler particles and particle size[11]. Recent advancements on the organic matrix and inorganic fillers have led to the development of new materials with reduced particle size and increased filler loading, and have resulted in improved mechanical properties and aesthetics on the current composite resin materials[12].

A wide variety of restorative materials are available nowadays, the recent ones being Nanocomposites. Today, nanotechnology has become a popular discipline in science and technology. Nanotechnology is the production of functional materials and structures in the range of 0.1 to 100 nanometers by various physical and chemical methods[6,13]. Fibre reinforcement of conventional dental composites was also introduced

with the aim of enhancing their physical and mechanical properties, and increasing their resistance to fracture. The enhancement of the material properties was due to the stress transfer from the matrix to the fibres depending on the fibres length and diameter. Garoushi et al. studied their effect, and found a significant improvement in the materials physical properties.[14] However, in the complex oral environment it can be assumed that both teeth as well as the restorative materials are subjected to low pH values, leading to degradation of their surface integrity. The aim of this study was to determine the effect of Mirinda orange, Seven Up and Appy fizz on Microhardness of Nanohybrid Composite and fibre reinforced Composite.

Materials and Method

Disk-shaped specimens (07 mm in diameter and 2 mm thickness) were prepared from each nanohybrid composite (any-com, USA) and fiber reinforced composite (ever X posterior). A mylar strip was placed over filled mold after which light pressure (20 N) was applied. The specimens were polymerized for 40 seconds with light-activated polymerization unit (Elipar 2500; 3M ESPE, USA). A total of 28 samples were made for each of the composites (Nanohybrid and Fiber reinforced). Seven samples (n = 7) from each composite group were immersed in four solutions, that is , Distilled water , Appy fizz, Mirinda orange, and Seven Up (7 × 4 = 28 samples). The specimens were dipped for 50 seconds and washed with saline. This cycle was continued for six times each day. All specimens were stored in artificial saliva during study. Vickers hardness test was carried out in regular intervals for 7, 14, and 21 days. The Vickers Microhardness was determined by applying a force of 100 gms with a dwell time of 15 seconds. Indentation of a static diamond tip under load into the material being tested for a certain period of time constitutes hardness test. Evaluation of microscopic impression produced from this procedure was performed after the removal of the load. Since the diamond is pyramidal in shape in Vickers' hardness test, a square-shaped impression was obtained in the material being tested. Measurements were made on both diagonals, and mean values were obtained.

Statistical Analysis

Data were analyzed by one-way analysis of variance followed by Tukeys post hoc test.

Results

There was reduction in microhardness , but no significant difference in groups tested after 7 and 14 days ($p > 0.05$)

There was significant reduction in hardness in both composites after 21 days of immersion. [Table 1 and 2] Microhardness reduced significantly after 21 days of immersion in Mirinda orange the most followed by Seven Up and Appy fizz. Fiber reinforced composite has superior resistance to degradation as compared to nanohybrid composite resins.

Table - 1

Group	7 Days	14 Days	21 Days
Mirinda	56.2	55.6	53.4
Seven Up	56.5	55.4	54.5
Appy Fizz	57.4	56.5	55.6
Control	58.6	58.6	57.6

The mean microhardness values for fibre reinforced composites

Table - 2

GROUP	7 Days	14 Days	21 Days
MIRINDA	51.7	49.6	46.3
SEVEN UP	52.4	51.5	49.5
APPY FIZZ	54.3	53.6	52.0
CONTROL	54.4	54.2	53.9

The mean microhardness values for nanohybrid composites

Discussion

One of the most important properties that determine the durability of dental materials in the oral cavity is their resistance to dissolution or disintegration which is affected by common consumable foods and drinks (e.g., water, carbonated soft drinks, alcoholic drinks, food derivatives)[15]. Studies have shown that resin-based restorations undergo greater micro morphological damage following an acid challenge for a prolonged time.[16] The present study was aimed to determine the surface microhardness of different restorative materials after exposure to different solutions. In our study, sample size was standardized and uniform depth of cure was maintained. During consumption, food or drink contacts teeth or restoration surfaces for only a short time before it is washed away by saliva.The restorative materials were immersed in acidic drinks for 50 seconds, then washed with saline, and the cycle was repeated for six times per day. The above time period was selected to simulate *In vivo* conditions of oral cavity, where the salivary flow dilutes the acidic concentration of beverages.[2,17]

Erdemir et al stated that restorative materials displayed a tendency to erode under acidic conditions and the acids in these drinks promoted the release of unreacted monomers by penetrating into the resin matrix, thereby resulting in lower surface hardness values.[9,18] In this study, no significant reduction in microhardness was seen after 7 and 14 days, but there was significant reduction after 21 days. This might be due to time taken for beverages to dissolve the composite materials. Phosphoric acid and carbonic acid present in beverages might have been responsible for reduction in microhardness.[19] Low pH induces erosive wear in composite material and decreases the microhardness.[20]

A wide variety of restorative materials are available nowadays, the recent ones being Nanoionomers and Nanocomposites. Today, nanotechnology has become a popular discipline in science and technology. Nanotechnology is the production of functional materials and structures in the range of 0.1 to 100 nanometers by various physical and chemical methods. Inclusion of nanofiller and nanoclusters of filler material provides enhanced esthetics, improved polishability and enhancement of certain physical characteristics of the restorative material in the mouth.[13]

Fiber reinforced composites leads to significant increase in physical and mechanical properties, such as flexural strength, flexural modulus, fracture toughness, and Vickers hardness.[14] The enhancement of the material properties was explained to be due to the stress transfer from the matrix to the fibers and also due to the action of the fibers in stopping crack propagation

through the material. It was found that the mere insertion of fibers is not enough to enhance the composite properties, that is, the fibers length and diameter play a critical role in this mechanism. Peterson found that fibers incorporated into a material, greatly enhances its mechanical properties, on the condition that the fibers have a length that exceeds a certain minimum length.[14] Rios et al stated that 21 days period of immersion was enough to produce significant differences in surface roughness and microhardness as acidic beverages were able to cause chemical degradation in the polymer of all dental composites tested. Distilled water used as control showed reduction in Microhardness , due to water sorption and polymer degradation. "water serves as a plasticizing molecule within the composite matrix, causing a softening of the polymer resin component.[17]Appy fizz (pH-4.8) is a carbonated beverage that contains acid. The acids present in this will soften the bisphenol A-glycidyl methacrylate component and reduces the microhardness.[17] Seven up(pH-3.2) is an acidic drink with low pH that is responsible for the degradation of components. Mirinda orange was selected in this study because it has the lowest pH in all measured beverages. (pH -2.85) and citric acid in Mirinda causes damage to organic fillers.[3,4] Although this study could not completely replicate the complex oral cavity, it confirms the deleterious effects of some commercially available soft drinks on restorative materials, effects which patients should be aware of. The results of this study demonstrated that Mirinda orange decreased the micohardness to the greater extent than all tested materials because of the lowered pH.

Conclusion

The microhardness of material was reduced after 7 and 14 days, but this reduction in the test groups was not significant as compared with the controls.

Microhardness reduced significantly after 21 days of immersion in Mirinda orange followed by Seven Up and Appy fizz.

The decrease in microhardness also depends on exposure time, frequency of intake and chemical composition of composites and soft drinks. Fiber reinforced composite has superior resistance to degradation and high microhardness values as compared to Nanohybrid composite resins.

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