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Comparative Evaluation of Effect of Different Beverages on Surface Micro Hardness of Various Restorative Materials: An In Vitro Study

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INTRODUCTION

Smile is a window into one's personality. Teeth play a significant part in the maintenance of a healthy personality and an affirmative self-image. However, teeth loose their natural integrity due to caries, wearing, discolouration and fractures. There are various restorative materials introduced in the field of dentistry which helps in restoring the natural form and function of the teeth .The ultimate goal of dental restorative material is to replace the biological, functional and esthetic properties of healthy tooth structure.[1]

Nowadays, tooth coloured filling materials are widely used in restorative dentistry because of their good physical, mechanical and esthetic properties. The outstanding development of adhesive dentistry coupled with strong esthetic demands from patients has resulted in widespread use of resin composites in a dental practice.

Nanohybrid resin composite the newest resin composite restorative material is becoming popular because of it combines physical, mechanical and esthetic properties. It incorporates a high volume fraction of filler particles with a wide particle size distribution. The compressive and diametral strength and the fracture resistance of the nanohybrid resin composite is equivalent to or higher than those of other composites. Fantasista V (Fantasista, Tokyo Japan) (A2 Shade) is a visible light cure, tooth shade radio-opaque composite resin with the polymer matrix. It has a unparalleled translucency and ability to blend with shade of the surrounding tooth and its proprietary strontium filler adjusts the refractive index to complement that of the resin matrix.

Microfilled composite contain prepolymerized colloidal silica filler known as organic filler. They were developed to provide the dental profession with material that possessed outstanding polishablity and esthetics and resistant to plaque, debris and stains. Heliomolar (Heliomolar, Benderersträsse Sachan) (A2 Shade) is a micro filled radiopaque composite for restorative therapy and cures with light in the wavelength range of 400-500nm. The prepolymers used in Heliomolar are micro filled pre-polymerized composites that exhibit virtually the same properties as the matrix.

Glass ionomer cements have been used successfully in clinical dentistry for many years. Light cured GIC is a resin modified GIC (GC Gold Label, GC Corporation Tokyo Japan) (A2 Shade). Major advantage of the light-cured glass ionomer cement is that their initial set requires only 25 to 30seconds of visible Light exposure. In addition, they are much easier to handle clinically and customarily are not associated with dehydration and the resultant cracking.

Despite a notable improvement in the composition and characteristics of various esthetic restorative materials, whenever placed in the oral environment, they are subjected to a great number of adverse conditions that challenge their integrity and longevity over time.

In this era where adolescents and youngster's like to have fast food, soft drinks, energy drinks and tetra pack fruit juices are frequently consumed which can result in surface damage and decrease hardness, esthetic quality and other properties of restorative materials.

Coca-cola is a popular carbonated soft drink with a pH of 5.5containing carbonic acid and phosphoric acid which promotes dissolution and easily erodes the materials.[2]

Grando and co-workers (1996) showed that the erosive potential of an acid drink is not exclusively dependent on its pH, is strongly influenced by its tritratable acid content in beverages.[3]

Red bull which is another popular energy drink which contains the most common type of acid i.e. citric acid which also has a greater erosive potential and the pH 3.54.[4]

Beer is an alcoholic drink causing significant increase in the degree of corrosion of restorative material because of presence of alcohol that softens polymer matrices and dislodges filler particles resulting in a rapid decrease in micro hardness.[2]

Favorite all season drink lemonade is not only consumed by the youngsters, elderly peoples also enjoys. The pH of lemonade ranges from 2 to 3.

Physical characteristics of restorative materials are an important concern when determining suitable restorative materials because they strongly influence the clinical longevity of restorations.[5]

One of the most important properties is the material's hardness which correlates well with compressive strength, resistance to intra-oral softening, and degree of conversion[6] .A low surface hardness value is largely related to inadequate wear resistance[7] and proclivity to scratching, which can compromise fatigue strength and lead to failure of the restoration.[8]

The increased consumption of sports and energy drinks among the general population has raised questions about these drink's erosive potential on the clinical performance of restorative materials.
Abu-Bakar and others (2000) showed that alcoholic beverages and soft drinks affect the compressive strengths, micro hardness, solubility and surface texture of the restorative materials.[9]

Tanthanuch *et al* (2014) stated that the influence of the acidity increasingly dissolves the matrix, along with any unstable glass particles in a low pH value drink. High acidity also have a greater softening effect on the resin matrix, thus promoting the dislodgement and leaching out of filler particles and reducing the load resistance of restorative materials.[2]

Hence, the aim of this in vitro study was to evaluate and compare the effect of different beverages on micro hardness of different restorative materials.

AIM

To evaluate and compare the effect of different beverages on surface micro hardness(VHN) of various restorative materials after 1^{st}, 7^{th} and 14^{th} day of immersion. The surface micro hardness (VHN) of various restorative material will be calculated using Vickers's micro hardness testing machine

OBJECTIVES

1. To evaluate the effect of various beverages (Coca-Cola, Lemonade, Red-Bull and Beer) on surface micro hardness of various restorative materials {Nanohybrid composite(Fantasista V), Microfilled composite (Heliomolar)and Light cured glass ionomer cement} after 1^{st}, 7^{th}, and 14^{th} day of immersion.
2. To compare the effect of above mentioned beverages on the surface micro hardness of above mentioned restorative materials after 1^{st} ,7^{th} and 14^{th} of immersion.

MATERIALS AND METHOD

1. Specimen Preparation

A Nanohybrid composite, Micro filled composite and Light cure Glass ionomer cement (GIC) were selected for the study and were divided into three groups.

GROUP I: Nanohybrid Composite (Fantasista V, Tokyo Japan) (A2 Shade)

GROUP II: Micro filled composite (Heliomolar, Bendererstrasse Sachan) (A2 Shade)

GROUP III: Light cured GIC (GC Gold Label, GC Corporation Tokyo, Japan) (A2 Shade)

Thirty two disc shaped specimens of each restorative material were prepared using the custom made stainless steel cylindrical mould of standard dimension (10mm inner diameter and 4.0mm thick)

GROUP I (n=32): In group I disc were prepared by placing nanohybrid composite (Fantasista V, Tokyo Japan) (Shade A2) in a cylindrical mould in two increments using a composite placing instrument. Each increment will be light cured for 40 seconds using a LED to ensure complete polymerization.

GROUP II (n=32): In group II disc were prepared by placing micro filled composite (Heliomolar, Bendererstrasse Sachan) (Shade A2) in a cylindrical mould in two increments using a composite placing instrument. Each increment was light cured for 40 seconds using a LED to ensure complete polymerization.

GROUP III (n=32): Light cure GIC powder and liquid was dispensed according to manufacturer's instructions. The standard powder to liquid ratio is 3.2g/1.0g i.e. 1 level scoop of powder to 2 drops of liquid was taken. For accurate dispensing of powder, the bottle was tapped gently and for accurate dispensing of liquid bottle was held vertically and squeezed gently. The powder and liquid was dispensed on the paper pad the liquid was spreaded into thin layer with plastic spatula. For manipulation half of the powder was pulled onto liquid and mixed with lapping strokes (like impression material) for total 10 to 15 seconds then the remaining powder was pulled and mixed thoroughly to a glossy consistency. The mixing time was not to exceeded from 20-25 second.

For all restorative materials the disc were prepared by firstly placing the customized steel mould (10mm X 4mm) on the glass slab. The discs were prepared by placing two increments of each restorative material. The first increment was placed and cured for 40 seconds to ensure complete polymerization. Afterwards the second increment was placed in the cylindrical mould and in order to obtain a flat polymerized surface without bubble formation, the restorative material was covered with Mylar strip and pressed gently with glass slide.

Finger pressure was applied on the slide to extrude the excess material followed by curing for 40 seconds to ensure complete polymerization. Each increment of restorative material was polymerized using a light emitting diode (LED). The light curing tip of curing unit was placed perpendicular to the specimen surface. The distance between the light curing tip and specimens was standardized by using a 1mm glass slide. Light intensity was verified with a measuring device after each cure. Any form of additional polishing can lead to an increase in surface roughness and hence no polishing of the samples was carried out.

2. Evaluation of Baseline Surface Microhardness

The surface micro hardness of each specimen was determined using Vicker's micro hardness tester equipped with a diamond indenter. A standardized load of 100g or 0.1N was applied to the surface for dwell time of 10 seconds. Three indentations equally spaced over a circle were made on the surface of each specimen and the mean of these scores obtained was tabulated as the base line surface micro hardness.

3. Beverage Immersions

The specimen of 3 groups were randomly subdivided into 4 subgroup with each subgroup containing (n=8) discs according to the beverage used for the immersion.

SUBGROUP A (n=8) Coca-Cola (Coca-Cola company, Atlanta Georgia)
SUBGROUP B (n=8) Lemonade (Dutch Company, Koningskade Den Haag)
SUBGROUP C (n=8) Red-Bull (Red bull Gmbh, Fuschl am See Austria)
SUBGROUP D (n=8) Beer (United Breweries Company, Bangalore)

The pH of each beverage was determined using a pH meter .Ten pH reading of each beverage was determined using a pH meter. Ten pH reading of each beverage was obtained in order to give a mean pH measurement for each beverage. All the experimental beverages were refrigerated before use. 25 ml of each beverage was taken in a glass vial and the disc of all groups were immersed in the different beverages alternately for 5 min and then in distilled water .for rest of the day at room temperature in a closed container . This protocol was followed for 14 days.

In order to maintain the original pH level of beverages a new bottle was used every time of immersion and rest of the beverage was discarded.

POST IMMERSION SURFACE MICROHARDNESS TESTING

After the immersion sequence was completed, the specimens was rinsed with deionized water, blot dried and subjected to post immersion surface micro hardness testing.

Evaluation of surface hardness of specimens of all groups were carried out at the following intervals i.e. after 1st, 7th and 14th day of immersion using Vicker's micro hardness test. A gradual change in the surface micro hardness for all the restorative materials was recorded tabulated and was subjected to statistical analysis.

RESULT

The baseline surface micro hardness (VHN) for group I (Fantasista V) was 62.55, group II (Heliomolar) was 53.30, group III (Light cure GIC) was 49.28.

The mean value of surface micro hardness of different restorative materials without any immersion in decreasing order Fantasista V> Heliomolar> Light cure GIC

The mean value of surface micro hardness of Fantasista V when immersed in different beverages on 1st, 7th and 14th day; Coca-Cola (1st day 62.33, 7th day 60.08, 14th day 57.94), Lemonade (1st day 62.63, 7th day 61.28, 14th day 59.33) Red bull (1st day 61.48, 7th day 61.29, 14th day 59.78) Beer (1st day 62.23, 7th day 62.04, 14th day 61.85)

The mean value of surface micro hardness of Heliomolar when immersed in different beverages on 1st, 7th and 14th day ; Coca-Cola (1st day 49.69, 7th day 45.56, 14th day 41.82) Lemonade(1st day 50.48, 7th day 47.21, 14th day 44.26) Red bull (1st day 53.09, 7th day 49.10, 14th day 46.10) Beer (1st day 52.35, 7th day 51.27, 14th day 48.05)

The mean value of surface micro hardness of light cure GIC when immersed in different beverages on 1st, 7th and 14th day; Coca-Cola (1st day 45.05, 7th day 41.75, 14th day 37.91) Lemonade (1st day 42.46, 7th day 36.81, 14th day 32.68) Red bull (1st day 48.59, 7th day 43.28, 14th day 39.70) Beer(1st day 49.34, 7th day 44.02, 14th day 41.71)

Thus, the null hypothesis was rejected as all beverages used in this study showed reduction in surface micro hardness of the various restorative materials (Nanohybrid, micro filled and Light cure GIC) when immersed for 14 days.

When mean of baseline surface micro hardness (without any immersion of group I{Fantasista V Nanohybrid} was compared with mean of baseline surface micro hardness of group II {Heliomolar, Microfilled}, Fantasista V showed significantly higher surface micro hardness.

When mean of baseline surface micro hardness (without any immersion of group I {Fantasista V Nanohybrid} was compared with mean of baseline surface micro hardness of group III {light cure GIC}, Fantasista V showed significantly higher surface micro hardness.

When mean of baseline surface micro hardness (without any immersion of group II {Heliomolar, Microfilled} was compared with mean of baseline surface micro hardness of group III {light cure GIC}. Heliomolar showed significantly higher surface micro hardness.

When intra group comparison of group I was done, subgroup IA (Fantasista V, Coca-Cola) and subgroup IB (Fantasista, Lemonade) showed non-significant reduction of surface micro hardness on 1st day and significant reduction of surface micro hardness on 7th and 14th day. In subgroup IC (Fantasista v, Red Bull) there was non-significant reduction in surface micro hardness on 1st and 7th day but significant reduction on 14th day. In subgroup ID (Fantasista V, Beer) there was non-significant decrease on 1st, 7th and 14th day.

When intra group comparison of group II was done, subgroup IIA (Heliomolar, Coca-Cola) and Subgroup IIB (Heliomolar, Lemonade) showed significant reduction of surface micro hardness on 1st, 7th and 14th day. In subgroup IIC (Heliomolar, Red bull) there was non-significant reduction on 1st, day and significant reduction on 7th day and 14th day of surface micro hardness. In Subgroup IID (Heliomolar, beer) there was non-significant reduction of surface micro hardness on 1st and 7th day and significant reduction on 14th day.

When intra group comparison of group III was done, subgroup IIIA (Light cure GIC, Coca-Cola) and subgroup IIIB and (Light cure GIC, Lemonade) showed significant reduction of surface micro hardness on 1st, 7th and 14th. In subgroup IIIC

(Light cure GIC ,Red-bull) and subgroup IIID (light cure GIC , Beer) there was non-significant reduction of surface micro hardness on 1st day and significant reduction on 7th and 14th day.

Within the limitation of our study it was concluded that:

1. Nanohybrid (Fantasista V) showed maximum surface micro hardness (baseline and after immersion in different beverages for 14 days) followed by Micro filled (Heliomolar), followed by Light cure GIC.
2. All the restorative materials (Fantasista V, Heliomolar and light cure GIC) showed reduction in surface micro hardness when immersed in different beverages (Coca-Cola, Lemonade, Red-Bull and Beer) on 1st, 7th and 14th day of immersion.
3. In Fantasista V, Coca-Cola and lemonade showed non-significant reduction of surface micro hardness on 1st day but significant on 7th and 14th day. Red bull showed non-significant reduction of surface micro hardness on 1st and 7th day but significant on 14th day. Beer showed non-significant reduction on 1st,7th and 14th day.
4. In Heliomolar, Coca-Cola and lemonade showed significant reduction of surface micro hardness on 1st, 7th and 14th day. Red bull showed non-significant reduction on 1st day but significant on 7th and 14th day. Beer showed non-significant reduction on surface micro hardness on 1st and 7th day and significant on 14th day.

5. In light cure GIC, Coca-Cola and lemonade showed significant reduction of surface micro hardness on 1st, 7th and 14th day. Red bull and beer showed non-significant reduction of surface micro hardness on 1st day but significant reduction on 7th and 14th day.

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