

## International Journal of Dental Science and Innovative Research (IJDSIR)

# IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume - 5, Issue - 3, June - 2022, Page No. : 209 - 215

A Comparative evaluation of surface hardness of Componeers, Veneers and Laminates - Influence of commonly consumed beverages immersion after a short-term period - An in-vitro study

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Type of Publication: Original Research Article

**Conflicts of Interest:** Nil

## Abstract

The consumption of commonly available beverages has gained high popularity among the adolescent population, especially 18–35-year-olds. Previous studies indicated that these beverages potentially cause dental erosion and their acidity damage restorative materials. The use of dental ceramics has substantially increased over the past few years because of their good aesthetic appearance and ease of handling. The Componeers, Veneers and Laminates have revolutionized aesthetic dentistry. The aim of this in vitro study is to evaluate the effect of various beverages on the surface hardness of Componeers, Veneers and Laminates

A total of 60 human permanent anterior teeth (Central incisors) were chosen for this study. The teeth were divided to meet the requirements of the individual samples. Tooth preparation was then carried out using diamond burs and depending upon which sample group it belongs to, the appropriate restoration i.e., Componeers, Veneers (Zirconia) and Laminates

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(Composite) were placed on the respective teeth. Afterwards these specimens were placed in different test tube vials containing equal amounts of Coca Cola (The Coca Cola Company, Atlanta, USA), Coffee (Nescafe Gold, Switzerland), Red Bull (Red Bull gMbH, Austria) and Amul Cool Butterscotch milk (Amul Cooperative Dairies, Anand, Gujarat) This procedure was repeated for 30 days after which the samples were evaluated for surface hardness test. The results were then statistically analysed using one-way ANOVA followed by post hoc Tukey test.

There was statistically highly significant difference found in Surface hardness (VHN) among group I (Componeers), II (Veneers) & III(Laminates).

The present in-vitro study indicates that out of all the tested restorative materials: Componeers, Veneers (Zirconia) and Laminates (Composite), Veneers exhibited highest micro-hardness values.

However, further in-vivo studies are required to evaluate further mechanical properties of Componeers, Veneers and laminates in the oral cavity.

**Keywords:** Componeers, Veneers, Laminates, Vicker's hardness

#### Introduction

One of the greatest desires for a patient while going for a dental treatment is the aesthetic transformation of their smiles to include a healthy and harmonious dentition.<sup>(1)</sup> With the ever increasing demand for better results in anterior aesthetic corrections, recent advances have led to the development of newer materials and techniques which specifically aims at improving the aesthetic results of anterior teeth and allows for a minimally or even non-invasive approach, which causes little damage to the dental structures. This technique is innovative, highly aesthetic, and predictable in terms of both result and long-term prognosis. At the same time, it also

focuses on the three vital parameters that are: aesthetics, function and sound tissue preservation. Furthermore, any restoration should be able to reproduce the physiologic behaviour of the natural tooth as much as possible, with biological, biomechanical, functional and aesthetic integration. <sup>(2)</sup> While there are a number of treatment options to choose from in terms of aesthetic restorations in the anterior region, some of them include: direct composite restorations, composite or ceramic laminate veneers, and metal-free crowns (lithium disilicate, zirconia, alumina). Therefore, planning is a crucial step for a successful aesthetic rehabilitation treatment.

Therefore, the first and foremost therapeutic option should be a conservative treatment, that is being able to modify the shape, size and colour of the teeth and at the same time providing a result according to the patient's expectations <sup>(3)</sup>.

Veneering is a minimally invasive restorative procedure for anterior teeth where the buccal surface of the tooth is involved and clinical need is mainly to improve the aesthetics <sup>(1)</sup>. Veneering can be done either with porcelain or zirconia veneers or by composites. They provide excellent properties in terms of aesthetics, biocompatability and wear resistance but it is very technique sensitive, requires multiple visits and is costly for the general population.

Componeers <sup>(4)</sup> on the other hand represents an innovative approach that bridges between ceramic veneers and direct composite veneering. Made from nanohybrid composites, these are preformed composite shells with excellent buccal gloss surface and is less technique sensitive, single visit procedure and cost effective. These are extremely thin veneers(0.3mm), thus requiring minimal tooth preparation and give a natural look to the teeth.

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Another treatment option for patients is composite veneers <sup>(5)</sup> or laminates. Direct composite veneers allow operator to control and evaluate entire procedure from shade selection to final morphology usually in a single appointment.

However, to be clinically successful, aesthetic restorative materials are required to have long-term inertness. Consumption of beverages with low pH and acidic foods and drinks potentially cause dental erosion which may be detrimental to this inertness and influence mechanical and physical characteristics such as surface hardness over time <sup>(6)</sup>. Since caffeinated beverages, aerated beverages and milk-based beverages are the most commonly consumed beverages by the Indian population, this study focuses to evaluate the effect of short- term immersion in these beverages and their effect on surface hardness and abrasiveness of Componeers, Veneers and Laminates.

# Materials and methodology

Sixty anterior human teeth (central incisors) extracted for Periodontal reasons were obtained from Department of Oral and Maxillofacial Surgery, BBDCODS, Lucknow: after taking Patient consent. Teeth were cleaned for any tissue remnants, plaque and calculus on the roots with ultrasonic scalers.

## **Specimen preparation**

The teeth were divided to meet the requirements of the individual samples. Tooth preparation was then carried out using diamond burs depending on case requirement. Window type of preparation i.e., in which the incisal edge of tooth is preserved was done.

Depending upon which sample group it belongs to, the appropriate restoration i.e., Componeers, Veneers (Zirconia) and laminates (Composite), were placed on the respective teeth. After restoration, all the specimens were stored in distilled water in a lightproof container for 24 hours at 37°C to ensure complete polymerisation. Afterwards, 4 specimens from each experimental group were individually stored in vials containing 5 ml of distilled water (pH 6.58) for 24 hours, and kept in an incubator at 37°C as a control solution and the distilled water was renewed daily up to 1 month. The other specimens from each experimental group were individually immersed (n=4) in vials containing 5 ml of Coca Cola (The Coca Cola Company, Atlanta, USA; pH 2.6), Coffee (Nescafe Gold, Switzerland; pH 4.85) Amul Cool Butterscotch milk (Amul Cooperative Dairies, Anand, Gujarat; pH 6.7) and Red Bull (Red Bull gMbH, Austria; pH 3.54). They were immersed for 2 mins daily at room temperature after which the samples were washed with distilled water and the specimens were maintained in distilled water at 37°C for the rest of the day. The vials were sealed to prevent evaporation of both the control and test solutions. For the entire experimental period, newly opened test solutions were used each day. This procedure was repeated for 30 days.

#### Surface hardness measurements

Surface hardness of the specimens was evaluated using Vickers method with a microhardness tester (Reichert Austria Make, Sr.No.363798) at a load of 100 g with an indentation time of 10 sec. The dimensions of the indentations were evaluated using the optical microscope of the hardness tester and the data were independently averaged and reported in Vickers Hardness Numbers (VHN).

## Analysis of the sample

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After obtaining the values of each group, the following tests were performed using SPSS (Statistical Package for Social Sciences) Version 24.0 (IBM Corporation, Chicago, USA):

- One-way analysis of variance (ANOVA)
- Post hoc Tukey's HSD analysis.

## **Observation and results**

Table 1: Comparative evaluation of Micro-Hardness (VHN) among group I (Componeers), II(Veneers) & III (Laminates).

Groups	Restorative	Number	Micro-Hardness	
	Material		(VHN)	
			Mean	SD
Group I	Componeers	20	82.370	6.9385
Group	Veneers	20	349.110	16.5706
II				
Group	Laminates	20	91.170	5.4981
III				
Total			174.217	125.2192
ANOVA 'F' Value			3903.022	
Significance 'P' Value			0.001(HS)	



Table 2/ figure 2 reveals Comparative evaluation of Micro - Hardness (VHN) among group I (Componeers), II (Veneers) & III (Laminates). Mean Micro - Hardness (VHN) were found highest in Veneers i.e.,  $349.110 \pm$ 16.570VHN and it was lowest among Componeers i.e.,  $82.370 \pm 6.9385$ VHN. ANOVA test was applied to find significant difference between groups. There was statistically highly significant difference found in Micro - Hardness (VHN) among group I (Componeers), II (Veneers) & III(Laminates). (P=0.001) Table 2: Tukey's Post Hoc Analysis for inter groupComparison of Micro-Hardness (VHN).

Groups	Mean Difference in	Significance 'P'
	Micro-Hardness	Value
	(VHN)	
Group I vs II	-266.7400	0.001(HS)
Group I vs III	-8.8000	0.034(S)
Group II vs	257.9400	0.001(HS)
III		

Table 2 (a) reveals Tukey's Post Hoc Analysis for inter group Comparison of Micro-Hardness (VHN). Mean difference in Micro-Hardness (VHN)was found -266.7400, -8.8000&-257.9400between Group I vs II, Group I vs III, & Group II vs III respectively.

#### Discussion

During consumption of food or drinks, the teeth or the restorations come in contact with food/drinks only for a short period of time before it gets washed away with saliva. However, to the best of our knowledge, in previous studies, substrates usually had contact with acidic food or drink for a prolonged period of time and the situation did not account for the role of saliva. Therefore, in the present study, the restorative materials were immersed in various drinks for 2 min a day and then they were stored in distilled water for the rest of the day. Distilled water was used instead of artificial saliva because the artificial saliva storage medium is not considered to be a more clinically relevant environment. Moreover, according to a study by Turssi, et al  $2002^{(7)}$ they evaluated the influence of storage media on the micromorphology of resin-based materials and it was concluded that the distilled water and artificial saliva storage media showed similar results.

Since caffeinated beverages, aerated beverages and milkbased beverages are the most commonly consumed beverages by the Indian population <sup>(8,9,10)</sup>, this study

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focuses to evaluate the effect of short- term immersion in these beverages and their effect on surface hardness of Componeers, Veneers and Laminates.

The present results reveal that there was a statistically highly significant difference found in the surface hardness among Componeers, Veneers and Laminates where the mean micro-hardness VHN was found to be highest in Zirconia Veneers i.e.,349.110±16.570VHN.

One of the reasons for highest surface hardness of Zirconia Veneers was because of its phase transformation toughening (PTT) mechanism that prevented crack propagation in the material <sup>(11)</sup>. This shows a contemporary 4–5% increase in crystals volume, thereby creating significant compressive stresses within the material. <sup>(11)</sup> According to Fernando et al <sup>(11)</sup>, Surface finishing technique did not influence the mechanical performance and neither did the cementation technique.

The LTD low temperature degradation(LTD) is a multifactorial phenomenon affected by several variables like crystal dimension, temperature, surface defects, manufacturing techniques, percentage and distribution of stabilizing oxides, mechanical stress and wetness.<sup>(12)</sup>Out of these factors, mechanical stress and wetness are known to significantly accelerate zirconia aging.<sup>(12)</sup> Although aging is considered a risk factor for mechanical failure, till date no univocal correlation has been evidenced between this phenomenon and the failures affecting zirconia during clinical service..<sup>(13)</sup>

In the present study, Componeers and Composite Laminates showed similar Vicker's Hardness number even with different composition and manufacturing mechanisms. Now hardness is defined as the resistance to surface indentation and can be used as an indirect method for measuring the degree of polymerisation. The hardness of a material is extremely influenced by their composition <sup>(14)</sup>. The most common scientific classification used for resin composite is related to the inorganic size. These materials can be classified as micro filled, micro hybrid and nanocomposites (i.e., Nano fill or nanohybrid) according to the filler size <sup>(14,15).</sup> Micro hybrid composites usually show higher hardness in comparison to nano filled and micro filled resin, since materials with high inorganic filler size tend to exhibit higher mechanical properties. In this study, Componeers and composite laminates show similar inorganic content, which explains the Vicker's hardness values observed.

Surface hardness of restorative materials was adversely affected when they were exposed to highly acidic drinks. Moreover, caffeinated drinks also have shown to have a damaging effect on the microhardness of the restorative materials that have been used in oral dentistry <sup>(16)</sup>.

Hwang et al. found that the lower the pH of the solution, such as in Coca-Cola and Red Bull, the greater the decrease in microhardness of the restorative material <sup>(17)</sup>. The large decrease in microhardness may be related to the increase in surface roughness under the influence of beverages. The results show a significant correlation between the consumption of beverages and microhardness reduction, promoting the destruction of filling and aesthetic work.

The results of this present study showed that microhardness decreased from the 1<sup>st</sup> week until the end of the 28 days period of immersion in coffee. Although the pH of coffee is nearly 7, coffee is composed of water, and the effect of water uptake can degrade polymer materials.

When polymer materials absorb water, coupling agents cause hydrolysis and loss of chemical bond between filler particles and the resin matrix. Filler particles dislodge from the outer surface of the material thereby decreasing the hardness. The effect upon the resin matrix

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and the degradation of the resin-filler interface and inorganic fillers may also play a role in the reduction of surface hardness.<sup>(18)</sup> This may explain why Componeers and Laminates, which contains silica/barium glass, shows hardness decrements when exposed to non-carbonated beverages.

Pereira et al. broke down the contents of milk-based beverages. It contained 1200 mg of calcium per litter. One glass of cow milk (245 g) contained 119–124 mg of calcium that fulfills 37–40% of the body's calcium requirement. Cow milk is also a good phosphate source and thus reduced changes in surface hardness can be attributed to its high phosphate content and low acidic content. <sup>(19)</sup>

#### Conclusion

Within the limitations of this in vitro study, it may be concluded that all tested beverages influenced the Vickers microhardness of tested restorative materials. The results of our study have shown substantial differentiation of mechanical properties of the materials used in conservative dentistry nowadays, depending on different conditioning environments. The results can influence the choice of the material used by a dentist, after taking into account the patient's eating habits.

It can also be concluded that Zirconia Veneers are amongst the most versatile materials available for Esthetic treatment. Their strength is unrivalled for and it has been rightly termed "ceramic steel" as it's the strongest ceramic material around. They are highly durable and can last anywhere between 10 to 30 years with proper care.

However, further in-vivo studies are required to evaluate the mechanical properties of Zirconia Veneers in the oral cavity.

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