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Review Article

DETERMINATION OF THE EFFECT OF SOCIALLY ACCEPTABLE BEVERAGES ON THE COLOUR STABILITY OF COMPOSITE RESTORATIONS

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ABSTRACT:

Introduction: Esthetic failure is the commonest reason for replacement of restorations. Consumption of certain beverages may affect the esthetic and physical properties of the resin composite, thereby undermining the quality of restorations.

Aim: To determine and evaluate the colour stability of composite restorations when immersed in socially acceptable and commonly consumed alcoholic beverages for 14 days.

Materials and method: 50 composite disks were prepared with the help of a mould made of rubber base impression material and later finished and polished. The samples were divided into 5 groups (n=10) and immersed in distilled water (as control), red wine, beer, brandy and whisky for fifteen minutes every day for fourteen days. The colour change of the samples was measured using a spectrophotometer on the first (24hrs) and fourteenth day.

Results: Comparing all the beverages, red wine showed the maximum colour change with a ΔE^* value of 12.08. The least colour change among the beverages was seen in whisky that had a ΔE^* value = 5.45. Even the control group in distilled water showed a ΔE^* value of 0.89.

Conclusion: At the end of this study, it was evident that alcoholic beverages do produce discolouration. The rate of this discolouration depends upon the characteristics of the beverage and the composite material as well as the time period of immersion. Hence it is imperative to educate the patients regarding the effects of alcoholic beverages on their restorations too.

Keywords: Composite, esthetics, alcoholic beverages, discolouration

INTRODUCTION

Our chief concern about restorations have always been about their durability and esthetics. With the advent of composite resin restorations, the desire of the patient to have functional and esthetically pleasing restorations has increased [1].

Composite restorations not only restore the aesthetics but also the form and functions of the tooth evenly. Apart from being economical, composite resin is relatively easier to handle and also gives satisfactory results when the clinical protocols are well conducted [2]. They have not only replaced posterior amalgam restorations, but are also employed in the direct restorations of anterior teeth due to their natural polychromatism [3]. The prime reasons for replacement of restorations is secondary caries and discolouration of the dental material [4].

The advancements in dentistry and its materials have enhanced the quality of composite restorations. Yet its discolouration is still an unsolved problem in the clinics [5].

Generally, discolouration is classified into intrinsic and extrinsic depending upon their source [6]. The intrinsic factors alter the resin matrix and their interface with the fillers thereby allowing penetration of the colourants causing discolouration [7]. On the other hand, the extrinsic factors stain the resin by either adsorption or absorption of colourants. Oral hygiene, personal habits and diet of the patient play a critical role in discolouration [8]. The quality of restorations is compromised by certain beverages that alter the aesthetic as well as the physical characteristics of resin composites. The beverages contain chemicals that are capable of causing degradation of the surface of the restorations, leading to loss of esthetics due to production of stains. In addition to this, the acidic pH of the beverage erodes the surface [9].

Alcohol is one of the most commonly consumed beverages in the world [10]. Hence it is common for dentists to come across patients who consume alcohol. Alcohol is also known to stain composite restorations which the dentists should be aware of during placement of composite resin restorations. The type of alcoholic drink and their intensity of staining has not been sufficiently studied and published for optimal awareness of the dentists as well as the patients.

The spectrophotometers, colorimeters and digital image analysis techniques are the most commonly employed methods to evaluate colour change. Amongst these, the spectrophotometer is found to be the most accurate [11]. It uses three-dimensional coordinates of L*a*b* system that was developed by the Commission Internationale de l'Eclairage [12].

Various studies comparing the effect of alcoholic and other non-alcoholic beverages on the aesthetics of composite are found in literature, but there are no reports comparing the various alcoholic beverages. The purpose of this study was to evaluate the colour change of tooth coloured composite restorations when immersed in four different socially acceptable and commonly consumed alcoholic beverages in South India.

Materials and methodology

Requirements of the study

- Resin Composite (Ivoclar Vivadent Tetric N Ceram A1 shade)
- Light cure (Ivoclar Vivadent Bluephase N LED light cure unit)
- Rubber base putty consistency impression material (Dentsply Aquasil)
- 50 ml of Distilled water
- 50 ml of Four different types of alcoholic beverages –
  - Beer (Heineken)
  - Brandy (Morpheus)
  - Whisky (After Dark)
  - Red wine (Fratelli Sette)

Preparation of the composite samples

Fifty disk shaped samples each of 10 mm diameter and 2 mm thickness of Tetric N Ceram composite were prepared. To make the disks, a mould using rubber base impression material (Dentsply Aquasil) was made. The disks were light cured individually through an acetate matrix for uniform curing using the Ivoclar Vivadent Bluephase LED unit that operates with an output of 1100 mW/cm^2 on high mode for 20 seconds. Each disk was then finished and polished in wet condition using the Super-Snap buff disks. All the samples were then stored in distilled water for 24 hours at 37°C for rehydration and completion of polymerization [7]. In addition five such composite disks were made as reference samples that were unstained throughout the study.

Measurement of baseline values

After immersion for 24 hours in distilled water, the samples were blotted dry and the baseline values for the colour change were obtained. A spectrophotometer was used to measure the colour change.

Staining the samples

Four different types of socially accepted alcoholic beverages – Beer, Brandy, Whisky and Red wine were used. The fifty composite disks were randomly divided into five experimental groups (n=10) corresponding to the staining solutions. The grouping was as below:

Group 1 - Composite disks immersed in Distilled water (control)

Group 2 - Composite disks immersed in Beer

Group 3 - Composite disks immersed in Brandy

Group 4 - Composite disks immersed in Whisky

Group 5 - Composite disks immersed in Red wine

Once the baseline values had been evaluated, the samples were immersed in 50 ml of the respective staining solutions for a period of 15 minutes every day for 14 days. The staining solutions were renewed each day to prevent contamination. After the immersion period, the samples were rinsed in tap water and stored in artificial saliva (NeutraSal). The colour change in the samples were measured prior to and after the first and fourteenth day of immersion. The samples were rinsed in tap water for 10 seconds and blotted dry with the help of a tissue paper before re-measurements.

Analysis of colour change

A spectrophotometer was used to measure the colour change of the samples. It works based on the CIE L*a*b* system. The CIE system determines colour in a three-dimensional space. The measurements were performed at the centre of each disk and repeated thrice. The colour change of the stained samples with respect to the colour of the reference (non-stained) samples were calculated using,

$$\Delta L^* = L_{sample} - L_{reference}$$

$$\Delta a^* = a_{sample} - a_{reference}$$

$$\Delta b^* = b_{sample} - b_{reference}$$

The total colour change was determined by evaluating the undesirable colour change ΔE* using the formula,

$$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where, the **L*** represents the measure of lightness or darkness, the **a*** represents the measure of redness (positive a*) or greenness (negative a*) and the **b*** represents the measure of yellowness (positive b*) or blueness (negative b*).

The mean of the values thus obtained was calculated.

Results

The changes in the CIE-Lab colour coordinates for each of the composite disks immersed in the staining solutions at the end of the 14 day – immersion period is tabulated below. In earlier studies, it has been established that the clinically acceptable threshold of ΔE* is 3.3. The colour changes observed in all the groups other than the control group are greater than the acceptable threshold. The interactions between the staining solutions and the composite resin produced statistically significant results in colour change *(P < 0.001)*. The greatest colour change i.e., ΔE* was 12.08 and hence the strongest absorption was seen in the composite disks immersed in Red wine i.e., Group 5.

The results can therefore be interpreted as colour change produced by Red wine > Beer > Brandy > Whisky.

Only the control Group 1-Distilled water had a ΔE* value of 0.86 that was lesser than the acceptable threshold thus showing minimal colour change.

Table 1:

GROUP	L*	a*	b*	ΔE* value
Group 1-Distilled water	**-0.38**	**0.53**	**0.56**	**0.86**
Group 2-Beer	**-0.94**	**4.66**	**6.14**	**7.77**
Group 3-Brandy	**-0.77**	**3.98**	**4.59**	**6.13**
Group 4-Whisky	**-0.65**	**3.33**	**4.26**	**5.45**
Group 5-Red wine	**-1.09**	**5.15**	**10.87**	**12.08**

Discussion

Discolouration is one of the biggest concerns of the patients and dentists and consumes their money and time. This study was aimed to evaluate the discolouration of resin composites in-vitro using socially consumed alcoholic beverages as the discolouration media. Today we see an increase in the number of people consuming various forms of alcohol and the term 'social drinking' has gained popularity. In such a scenario, it is of utmost importance to know the ill effects of alcohol on composites restorations in addition to its effects on general and dental health.

Previously, several studies have evaluated the discolouration caused by red wine and whisky but not many have discussed the effects of brandy and beer. Since, we have consumers for all types of beverages, it became even more reasonable to select them all as the staining solutions.

Anything that we consume is washed away by saliva after it comes in contact with the tooth structure for a short period of time [9]. This is the reason for choosing an immersion sequence that allowed the composite disks to contact the staining solutions for fifteen minutes everyday. The disks were stored in artificial saliva for the rest of the day to imitate the oral environment. The colour change was measured at two-time intervals i.e., first and fourteenth day of immersion to evaluate the effect of time on the depth of discolouration.

Time was found to be a critical factor for the color stability of tooth colored restorative materials [13]. This study also showed that as time increased, the intensity of colour change increased. These results are in accordance with the results stated by Gupta et al [14].

The colour change can be determined by two methods - Visually or by using Colorimeter [15] and Spectrophotometer. Since visual methods are not accurate and reliable, instruments are most widely used to measure discolouration. Spectrophotometers contain monochromators and photodiodes that measure the reflectance curve of a product's color every 10 nm or less and are considered more accurate when compared to the colorimeters [16]. Hence, it was used in this study. The amount of colour change at the end of the immersion period was denoted by ΔE. The quality of color was measured by CIE-Lab coordinates.

Ruyter et al reported that a colour change (ΔE^*) of 3.3 is visually perceptible [6]. Therefore, in this study, colour changes of $\Delta E^* \geq 3.3$ were considered to be clinically unacceptable [16,17].

All kinds of beverages contain certain colourants which is either adsorbed or absorbed by the resin matrix of the composite causing discolouration. The water sorption rate determines the ability of the resin to take up extrinsic stains [18].

Eick et al stated that silorane resins that are hydrophobic have water sorption rates lesser than that of methacrylate-modified polysiloxane and dimethacrylate resins [19]. Several studies have shown that TEG DMA and Bis-GMA cause the resins to be hydrophilic and increased water absorption [20] takes place in comparison to UDMA. Hence, UDMA is more resistant to stain than other methacrylates [21].

Increased water sorption causes expansion and plasticization of the resin which leads to hydrolysis of the saline, thus causing microcracks. The microcracks are essentially interfacial gaps between the filler and the matrix. These gaps cause discolouration by allowing the stain to penetrate [22].

As a result, the micro and nano-hybrid fillers are more colour-resistant than the macro fillers. Micro-filled have particles that are closely and compactly arranged. In nano and hybrid filled, the smaller particles fill in the gap between the large particles, thus reducing the voids between the matrix and filler [20]. Hence, they have lesser water sorption. Lesser water sorption causes less filler-matrix debonding and lesser hydrolytic degeneration. The water sorption and solubility reduce with increase in the interaction between filler particles and resin matrix. This interaction increases with increased surface area of the fillers as seen in nano technology [23].

Previous studies have stated that beverages with lower pH have a greater erosive effect on composite [24]. When the resin comes in contact with the acidic medium, there is loss of structural ions causing softening of the polymer surface. This in turn affects the surface integrity of the polymer thus negatively affecting the wear resistance of composite materials and increasing their degradation [25]. In this study, we have made no efforts to test the pH of the staining solutions. Red wine was found to be the most acidic according to earlier studies [26] and thus red wine must have caused the maximum discolouration.

Generally, beverages are known to have varying concentration of protein, amino acids (tryptophan, phenylalanine and tyrosine) and riboflavin. Earlier studies have concluded that these amino acids increase the staining potential of the beverage [27]. They have estimated beer to have the maximum amino acid content of 2 g/ 150 ml and trace amounts in other beverages. The intense staining by beer and red wine is probably due to the presence of large amounts of these colourant species present in the beverages. Thus, this is attributed to the increased staining capacity of beer.

Though in vitro, this study will still be able to give both clinicians and patients the ability to evaluate the effect of patient's lifestyle habits on dental restorative treatment procedures.

Conclusion

From this study, the following can be concluded:

- All beverages cause a perceptible and undesirable colour change of currently available composite resin restorations that have a ΔE* > 3.3.
- Red wine produced the maximum colour change.
- The colour change was time-dependent i.e., the colour change intensified with increased contact time.

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