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Effects Of Black Tea And Coffee On The Colour Stability Of Glass Ionomer Cement - An *In Vitro* Study

Research Article

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Abstract

Background: Glass ionomer cements are restorative materials which bind to the surface of the tooth and additionally act as filling materials. The colour of the GIC chosen is subjective to the colour of the tooth. The colour stabilising property refers to the ability of the restorative material to maintain colour irrespective of the environmental changes. GIC also has the ability to resist discoloration when exposed to various liquids in the oral cavity. The aim of the present study was to determine the effects of black tea and black coffee on the colour stabilising property of different commercially available glass ionomer cements.

Materials and Method: Two commercially available GIC brands - shofu and D-tech, were chosen to test the colour stability of GIC. The GIC pellets were immersed in black tea, black coffee and distilled water for three days and the values from the spectrophotometer were recorded and analysed pre and post immersion.

Results: On performing the paired independent sample t test for the different glass ionomer cements used, Shofu brand of glass ionomer cement had low delta E values. The p value was found to be 0.036 for samples immersed in the beverages and the control. It was statistically significant.

Conclusion: The present study concluded that the Shofu brand of glass ionomer cement has the highest colour stability, due to their low delta E values. GIC samples stained with black tea were least color stable.

Keywords: Glass Ionomer Cements; Discolouration; Spectrophotometer; Color Stability; Innovative Technology.

Introduction

Restoration refers to any process which helps in re-establishing the normal morphology, function and integrity of the damaged tooth. The most customary dental restorative material used is glass ionomer cement (GIC) [1]. The reaction of calcium alumino fluorosilicate glass with an ionomer acts as the basis for the formation of glass ionomer cements. The components of a glass ionomer cement primarily consist of an acid, a base and a medium which is predominantly water [2]. These components along with its micromechanical strength help in adhesion of the glass ionomer cement to bond to the tooth surface. In addition, GICs help in restoration of primary teeth, act as liners and bases and act as a retrograde filling material. Further, GICs also help in prevention of dental caries due to its fluoride releasing property. The widespread use of glass ionomer comments in dentistry has led to the classification of GICs into four major groups which are used for luting crowns and bridges, aesthetic restorative cements, reinforced restorative cements and lining cements and base respectively. These glass ionomer cements differ with respect to their powder-liquid ratio but were similar in composition. Despite the advantages put forth, GICs lacked resistance to abrasion, sensitivity towards moisture and strength [3]. The glass ionomer cements used for pediatric procedures vary in implementation and me-

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chanical properties as compared to those employed for advanced dental procedures.

Colour stability is defined as the ability of any material to maintain its colour with time. Glass ionomer cements in general adopt the colour of the tooth and hence are aesthetically more appealing than other restorative materials [4]. However, with time the colour of dental restorative materials including GIC vary. This variation is directly proportional to the concentration and duration of exposure to factors which affect the colour of glass ionomer cement. The fluoride releasing property of GIC indirectly affects the colour stability of this restorative material. Addition of resin components to glass ionomer cement decreases the hardening time for GIC but increases the physical strengths and resistance to wearing [5].

Resin modified glass ionomer cements are known to undergo change in colour and this property is attributed to the photo polymerisation of the resin present, during the decelerated acid-base reaction. Based on the number of photons absorbed by the glass ionomer cements, the values are determined by a spectrophotometer [6]. Encapsulated glass ionomer restorative cements have been introduced whose physical properties surpass conventional glass ionomer cements [7]. The colour of restorative materials, in particular GIC, tends to vary with the type of liquids and solids consumed by the patient. The acidic nature of soft drinks, excess consumption of caffeine can indirectly alter the colour of glass ionomer cements but however vary with the initial time and duration of exposure. The present study was adopted to determine the effect of different beverages such as black coffee and black tea on the colour stability property of two different brands of glass ionomer cements.

Materials and Methods

To analyse the colour stability of glass ionomer cements, two different brands of commercially available glass ionomer cements (D-Tech and Shofu) were chosen. (Figure 1) The glass ionomer cements were purchased from an online dental store and processed and moulded into pellets of diameter 2mm. The pellets were trimmed and polished using a micrometer fixed with a fine polishing bur. The GIC pellets were then labelled numerically and those numbered 1, 2 were immersed in black coffee, 3 and 4 in black tea and 5, 6 in distilled water for each brand. Color stability was checked using Vita EasyShade Spectrophotometer.(Figure 2). The values from the spectrophotometer were noted and the GIC samples were soaked in black coffee, black tea and distilled water. The values from the spectrophotometer were recorded after immersion for 3 days at room temperature and compared.

Results

Table. 1 indicates the 'L', 'A' and 'B' spectrophotometer values of six samples of d Tech brand of glass ionomer cements prior to immersion in black tea and black coffee. 'L' indicates the lightness of the sample, 'A' indicates the coordinates for red or green colour while 'B' represents the coordinates for yellow or blue colour. From Table. 2, the pre immersion 'L', 'A' and 'B' values of the Shofu brand of glass ionomer cements are obtained. Table. 3 and Table. 4 represent the post immersion values 'L', 'A' and 'B' values for d Tech and Shofu brands of glass ionomer cements respectively. The delta E values of the individual samples of D- tech and Shofu brand of glass ionomer cements are indicated in tables 5 and 6. Samples 1 and 2 were immersed in black coffee, samples 3 and 4 were immersed in black tea while samples 5 and 6 were immersed in distilled water (control) for both d Tech and shofu

Figure 1. The picture represents the sample of two different commercially available glass ionomer cements- D-Tech and Shofu respectively post immersion. Samples numbered 1 and 2 were immersed in black coffee, 3 and 4 were immersed in black tea and 5 and 6 were immersed in distilled water.

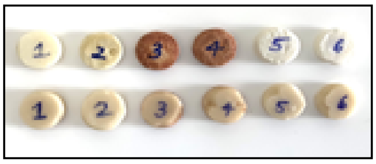


Figure 2. The recording of L,A,B values of each sample pre and post immersion in black tea and black coffee using VITA easyshade spectrophotometer.

Table 1. Table representing the pre-immersion spectrophotometer values of d-Tech GIC samples.

S. No	L value	A value	B value
1.	80	3	27
2.	85.8	1.6	31.9
3.	77.9	3.5	29.9
4.	78.9	3.6	32.2
5.	72.6	3.5	27.2
6.	80.1	2.8	29.5

Table 2. Table representing the pre-immersion spectrophotometer values of Shofu GIC samples.

S.No	L value	A value	B value
1.	76.2	8.4	30.5
2.	82.5	6.7	27.5
3.	76.4	7.2	27.6
4.	76.7	8.8	31.7
5.	80.3	7	28.7
6.	83.6	6.7	28.3

Table 3. Table representing the post immersion spectrophotometer values of D-Tech GIC samples.

S.No	L value	A value	B value
1	74.4	2.3	24.1
2	76.5	3.4	28.6
3	49.86	6.43	26.43
4	50.5	18.8	18.6
5	79	1.6	23.4
6	77.9	1.3	19.5

Table 4. Table representing the post immersion spectrophotometer values of Shofu GIC samples.

S.No	L value	A value	B value
1	75	7.9	27.6
2	81.2	6.8	26.8
3	62.5	17	23.1
4	63.2	16.6	28
5	80.1	6.7	24.6
6	81.7	6.4	23.5

Table 5. Table representing the delta E values of D-Tech brand of GIC.

S. No	Delta E value
1	6.345
2	10.031
3	28.405
4	34.965
5	7.682
6	10.348

Table 6. Table representing the delta E values of Shofu brand of GIC.

S. No	Delta E value
1	3.178
2	1.480
3	17.593
4	16.024
5	4.116
6	5.171

Table 7. Table representing the mean delta E values of D-Tech and Shofu GIC samples.

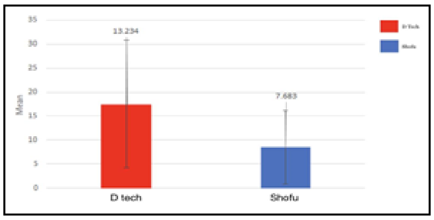
Sample	Black Coffee	Black tea	Control
D-Tech	8.18	34.96	9.01
Shofu	2.32	16.8	4.5

Table 8. Table representing the mean and standard deviation values of colour stability between D-tech and Shofu.

GROUPS		N	MEAN	STANDARD DEVIATION	SIGNIFICANCE
Delta E	D-Tech	5	17.486	13.234	0.036
	Shofu	5	8.478	7.683	

Independent sample t test was used to find the significance. P value less than 0.05 was considered to be significant.

Figure 3. Bar graph showing the comparison of mean delta E values and the samples of glass ionomer cements taken (D Tech and Shofu). X axis represents the different brands of glass ionomer cements while Y axis represents the mean delta E values of the samples. Blue colour represents the Shofu brand of glass ionomer cement while the red colour represents the D-tech brand. The p value was found to be 0.036 for D Tech and shofu. p<0.05 indicating statistically significant. From the graph, we can conclude that the Shofu brand of glass ionomer cement has the highest colour stability, due to their low mean delta E values. GIC samples stained with black tea were least color stable.



brands of glass ionomer cements. The mean delta E values of Shofu and d Tech brands of glass ionomer cements upon immersion in black coffee, black tea and distilled water are represented in Table. 7. On performing the independent sample t test for the different glass ionomer cements used, the respective mean and standard deviations for delta E values were compared as seen in Table.8. The p value was found to be 0.036 for D Tech and shofu. $p<0.05$ indicating statistically significant. From the graph, we can conclude that the Shofu brand of glass ionomer cement has the highest colour stability, due to their low mean delta E values. GIC samples stained with black tea were least color stable (Figure 3).

Discussion

On analysing the results obtained from the present study, it was found that the glass ionomer cements immersed in black tea showed maximum variation in colour as compared to those immersed in black coffee and distilled water. The average delta E values for the D-Tech glass ionomer cement was found to be 8.18 and 34.96 while the Sofu brand had an average of 2.32 and 16.80 for black coffee and black tea respectively. On comparing these delta E values, it was noted that the colour variation in the D-Tech brand was more significant as compared to the Shofu brand owing to its high delta E value. The p value was found to be 0.036 ($p<0.05$) for the samples immersed in both the beverages and the control group, indicating statistically significant values. The samples immersed in distilled water acted as the control as their delta E values remained a constant for the entire duration of the experiment. Further, the Shofu brand immersed in black coffee had the least change in colour when morphologically assessed. GIC samples stained with black tea were least color stable.

Colour stability, commonly known as chromatic stability, refers to the ability of any restorative material to resist a change in its colour on exposure to various substances and chemicals. Based on the duration of exposure and the substance involved, the colour change can be extrinsic in nature, a subsurface alteration or intrinsic discolouration [8]. The colour stabilising property of the restorative material is essential in determining the success of the restorative procedure in the long run. To test this property, various visual and instrumental methods have been developed, the most common one being spectrophotometric analysis [9]. This test determines the intensity of wavelength absorbed when light rays pass through the restorative material. Certain restorative materials tend to undergo a change in their physical properties and softening parallel to the colour change [10].

Based on a study conducted by Dalia Mohamed et al, it was stated that there was no significant difference in colour between glass ionomer cements immersed in coffee and distilled water. However, the change in colour of the cements varied with the duration of immersion. The change in colour was found to be maximum between the 7th and 30th days of immersion. On comparing the delta E values obtained for glass ionomer cements immersed in coffee and tea, it was noted that the values were higher for immersion in tea and thus the cements immersed in the same had the least colour stability which are in accordance with the results obtained from the present study [11].

In order to enhance the physical and mechanical properties of restorative materials, certain modifications in their composition are brought about, some of which include addition of metals, resins and nanoparticles [12]. In the research conducted by A.R. Prabhakar et al, it was observed that conventional glass ionomer cements were better resisted to change in colour as compared to resin modified glass ionomer cements, upon treatment with chlorhexidine. Further, the fluoride releasing capacity also varied inversely with the colour stability due to the higher dissolution of the surface of the restorative material. Thus, resin modified glass ionomer cements portrayed an increased release of fluoride ions [13].

The use of glass ionomer cements for various dental procedures has become increasingly popular due to their restorative property, fluoride releasing capacity and physical strength. The most essential factor which is considered when a restorative material is chosen, is its ability to match the colour of the tooth, the texture and roughness [14]. Based on previous studies, glass ionomer cements were known to possess less colour stability due to the presence of polyacidic substances in their composition. In certain modifications of GIC such as resin modified glass ionomer cements, the colour stability is decreased due to the From the article proposed by Yadav Chakravarthy, it was noted that the GICs produced maximum change in colour after immersion in red wine due to the high concentration of phenolic compounds [15]. On immersion in fruit juices, the colour of glass ionomer cements varied considerably in acidic juices as compared to alkaline and basic fruit juices. The pH of these juices could potentiate the release of hydrogen ions and facilitate erosion thereby comprising the colour of the glass ionomer cement. Irrespective of the duration of immersion, GIC produces discolouration and their ability to absorb water from the immersion medium aid in this process. Upon reaching saturation and stability, the change in colour is inhibited and the change in mechanical properties cease [16].

Our team has extensive knowledge and research experience that has translated into high quality publications [17-36]. The present study however possesses certain limitations due to its limited sample size and restriction to only two brands of GIC. In the future, the color stability of nanoparticles with added glass ionomer cements can be studied.

Conclusion

The present study concluded that the Shofu brand of glass ionomer cement has the highest colour stability, due to their low delta E values. GIC samples stained with black tea were least color stable.

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