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Shade Changes of Resin-Based Teeth and Ceramic Crowns After Exposure to Aerated Drink.

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ABSTRACT

The consumption of aerated drinks becomes a daily dietary controversial habit, due to presence of caffeine in these beverages, which has the effect of invisibility to get used to these drinks. There are many persons used fixed and removable dental prosthesis that made from either acrylic or ceramic crown and they already drink these beverage. Twenty methacrylate-based resin artificial teeth and twenty ceramic crowns were selected with light shade (1M1) and immersed in aerated drink for 30 days then the shade was measured by spectrophotometer device. There was significant difference between shade of acrylic teeth pre- and post-immersion, while the ceramic specimens were not affected by this experiment.

Keywords: acrylic resin teeth, ceramic crown, aerated drink, shade change.

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INTRODUCTION

The consumption of aerated drinks becomes a daily dietary controversial habit [1].

There are many factors has helped the growth and spread of aerated drinks, including the presence of caffeine in these beverages, which has the effect of invisibility to get used to these drinks. The annual consumption of these drinks began significantly increasing[2].

A large segment of oral rehabilitated people was used different kinds of prosthesis like acrylic complete and partial dentures and ceramic fixed partial dentures, and they are exercising their eating habits naturally in terms of aerated drinks because they believe that it helps the digestion process[2].

It is self-evident, any dentist when choose the appropriate material to compensate for teeth loss, there are three basic requirements to be achieved in this selection, adequate mechanical qualities, volumetric stability and esthetic look[3].

Not only the initial shade matchingis of the important objects in the selection of the artificial teeth to be used in rehabilitation in the esthetically sensitive areas, but the ability of these teeth to maintain the initial shade stability for a long time[4].

Because the shade change may cause an aesthetic problem, this change gives an impression of durability period and service life of the materials[5, 6, 7].

The acrylic teeth are used more frequently because of its ability to chemical adhesion with the acrylic denture base and resistance to chipping, and for ease of chair-side selective grinding [8, 9, 10], but where some disadvantages such as surface wear, and to overcome this problem, there is high strength acrylic teeth have been improved and utilized clinically[10].

Regardless of all other clinical factors of preference between acrylic and ceramics prosthesis, the ceramic features a close-fitting appearance of natural teeth and reflects the color and texture in close proximity also has the advantage of keeping the gloss and luster for long periods and it has resistance to wear and scratch, it also may be less affected by coloring solutions as well is not to absorb water, which is a hydrophobic material[11].

It is both advanced and more the ceramics are regarded as ultimate anterior esthetic materials, because it has similar most of optical properties to real teeth[12].

The most important factors affecting the shade stability is the exposure to extrinsic dyes and tints attached to the external surfaces, especially surfaces that eroded due to the exposure to the oral environments, and the rough surfaces that poor resistant to chemical and mechanical wear[9, 10, 13].

The exogenous dyes that caused by adsorption of the stain on external surfaces are considered as reversible and can be removed by cleaning and polishing processes[1].

There are tremendous efforts over the years to develop the esthetic properties of prosthetic materials to be ideal for esthetic qualities.All restorations should be comparable to the natural teeth and must maintain a stable color over the lifetime of the prosthesis[14].

Because of the preference for comparable materials for oral tissue, it is important to know any of the material is resistant to the change in shade and which is easy to change, the aim of the study was to investigate the effects of aerated drink on the shade stability of the acrylic teeth and compared to the shade stability of porcelain teeth.

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MATERIALS AND METHODS

Acrylic teeth specimen

Twenty methacrylate-based resin artificial teeth specimens were selected, which are upper central incisors(PIGEON DENTAL MFG.CO., LTD. UK) with shade (1M1) according to vita 3D master shade guide. The number 1 represents the value, the letter M represents the hue, and number 1 represents the chroma according to VITA® system 3D-master instructions[15].

Ceramic crowns specimen

A metal mold has been prepared for one tooth which is upper central incisors, then this mold was duplicated by using addition silicon (Zhermack, Italy), then these impressions were poured by high strength stone (Zhermack, Italy) to produce 20 dies, on this dies the crowns were made from e.max (Ivoclar, Vivadent, Schaan, Liechtenstein).

The contouring of the e.max was flat surface labially then investing was done by phosphate-bonded investment material (Zeus, Italy), then after pressing of e.max the brass ring was let to cool at room temperature for 60 minutes, divesting the ring and remove the reaction layer and complete the finishing process.

The veneering was done by layering technique started by blasting the restoration then cleaning and layering by IPS e.maxceram (Ivoclar, Vivadent, Schaan, Liechtenstein), staining was done with shade of (1M1) vita 3D master shade guide, finally glazing was completed.

Immersion of the specimens in aerated drink

The specimens were exposed separately in two containers of each type of specimens containing 250 ml. of Coca-cola (Coca-cola Company, Baghdad, Iraq). These containers were closed to prevent the evaporation of solution[16]. The solution was substituted daily for 30 days, to prevent the sugars in the solution from becoming acid and to reduce the precipitation of the particles in the solution [1, 8].

The specimens were exposed to solution for one hour three times daily at room temperature in dark field to preclude the unwanted effects of interfering light with the experiment [1]. After each dipping process, the specimens were washed with distilled water and stored for the rest of time in distilled waterat room temperature, which is changed daily within 30 days cycles[17, 18].

Measurement of shade of specimens

After completion of 30 days exposure, the specimens were washed with distilled water for 5 minutes after removing them from the containers, and dry them with tissue paper before measuring the shade [4]according to the manufacturer's instructions of the spectrophotometer measuring device (Zhengzhou smile industrial Co., Ltd, China).

Before each measurement the spectrophotometer device was calibrated [8, 19] by put the probe tip on the 100% white caliberation standard block according to factory instructions.

A mold of putty silicone was used to incubate the tooth to be examined so that the device probe can be fixed to each of the examined teeth in the same region for every measured tooth, where the re-examination of the same area is performed, provide black-background, also this silicon mold prevents the external light source from interposing with the machine light[8, 9].

The probe tip were placed on the center of the flat labial surface of the measured specimen teeth perpendicurarilly and flushed into the labial surface of teeth. The measurements were reiterated three times to secure a proper measurements.

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The Chi-square value of Statistical Package for Social Sciences computer program (SPSS) was used to analyze the data of this study.

RESULTS

The descriptive statistics appearsthe shade of acrylic specimens may change at the level of value, hue and chroma, and according the analytics statistics that representative by Chi-square between different experimental groups reveal a significant difference between acrylic specimens before and after the experiment at ($p \leq 0.05$),while the change of the ceramic specimens before and after immersion was 10 %, this change was non-significant according to the analytics statistics, as shown in table (1) and (2).

Table (1): Comparison of shade dimensions (value, hue and chroma) of acrylic teeth (A) and ceramic crown (C) after immersion in an aerated drink.

Shade dimensions	Acrylic (A)	Statistics	Ceramic (C)	Statistics
	After immersion (% change)		After immersion (% change)	
Value	85	X^2=147.8, P<0.001	5	X^2=1.5, P<0.06
Hue	80	X^2=133.3, P<0.001	5	X^2=1.5, P<0.06
Chroma	90	X^2=163.6, P<0.001	5	X^2=1.5, P<0.06

Table (2): Percentage of shade changes of acrylic teeth (A) and ceramic crown (C) after immersion in an aerated drink.

Shade	Acrylic (A)		Ceramic (C)	
	No.	%	No.	%
Unchanged (1M1)	0	0	18	90
Changed	20	100	2	10

The shade of the acrylic specimens after the experiment was changed from the light shade (1M1) toward the darker shades, while ceramic specimens was not changed significantly, as shown in table (3).

Table (3): Percentage of shade types of acrylic teeth (A) and ceramic crown (C) observed after immersion in an aerated drink.

Type of shade after experiment	Acrylic (A)		Ceramic (C)	
	No.	%	No.	%
1M1 (unchanged)	0	0	18	90
1R1.5	1	5	1	5
1R2	2	10	0	0
2R1.5	7	35	0	0
2R2	2	10	0	0
3R1	2	10	0	0
3R1.5	2	10	0	0
2M1	0	0	1	5
2M1.5	4	20	0	0
Chi-square value	17.273			
P- value	0.004			

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When comparing ceramic and acrylic specimens, there was a significant difference at ($p \leq 0.05$) in shade dimensions and shade types changed after experiment, as shown intable (3) and (4).

Table (4): Percentage of shade dimensions of acrylic teeth (A) and ceramic crown (C) after immersion in an aerated drink.

Shade dimensions		Acrylic (A)		Ceramic (C)	
		No.	%	No.	%
value	1	3	15	19	95
	2	13	65	1	5
	3	4	20	0	0
	4	0	0	0	0
	5	0	0	0	0
Hue	M	4	20	19	95
	R	16	80	1	5
	L	0	0	0	0
Chroma	1	2	10	19	95
	1.5	14	70	1	5
	2	4	20	0	0
	2.5	0	0	0	0
	3	0	0	0	0
Chi-square value		30.00			
P-value		<0.01			

DISCUSSION

Prior to the experiment, light-shade specimens were selected because the staining of these teeth was significantly appearing than the dark-shade teeth [19, 20], so the teeth with (1M1) shade were used in this study.

Based on the results of the experiment, the value, hue and chroma have changed for acrylic teeth, the teeth looked darker compared to the shade before the experiment and this was even observed visually, and came in line with many researchers[6, 21, 22, 23]. There was an increase in value and chroma, while the hue has shifted towards the red (R).

These apparent changes in shade may be due to extrinsic factors including:The adsorption and absorption of water by the resin that made the acrylic teeth[8, 24]. Water sorption consists of surface adsorption and matrix absorption. The surface adsorption is due to the polarity of the surface of resin material [7], while the matrix absorption is due to porosity, those factors causing the water of the Coca cola to enter the acrylic specimens' body and act as vehicle to the pigments[25] and penetrate between the molecular lattices[26]. The water uptake of the resin is a diffusion-controlled process, the diffusion coefficient of methyl methacrylate is high that cause increase in the rate of water uptake[27].The cumulative effect of dye solution may play a role in this change in shade due to the length of the experiment period. Some researchers consider that the period of month is a long time, but in contrast many others[8, 10, 13, 28, 29, 30]have relied on this period in their experiments.

The effect of acids in Coca cola, such as phosphoric acid and citric acid, that may cause chemical erosion of the profile topography of the specimens, lead to roughen the surface[31, 32], that increase the retention of the colored material[33].Also the roughness increases the surface area of the specimen that exposed to the colored materials of cola compared to the polished surfaces [34].

The low pH of Coca cola which is 2.2-2.8 [35]has had a negative impact on surface integrity and cause hydrolytic degradation that softening the matrix lead to increase solubility of the surface [26, 33]. Also caffeine found in Coca cola can cause discoloration of polymers [5, 6, 21].

There are intrinsic factors may cause this discoloration, due to the storage of specimens for a month may have increased the ageing process, which caused the change of the internal structure of resin[24].

The resin teeth are necessarily made from polymethyl methacrylate which contains benzoyl peroxide [11] which may cause deterioration of color stability [36].

The water diffusion may cause a chemical discoloration which is produced by the oxidation of the unreacted double bonds in the unpolymerized monomers of the polymer matrix, and the consequent formation of degradation products[37].

The hue has changed and shifted toward the red (R) not yellow (L), because the cola drink is free from yellow coloring agents as tea and coffee[32], and the caramel that exhibiting color of dark brown of cola beverage may cause this change[38].

The results were showed that the ceramic crowns were not affected significantly by the experiment and it resists the other factors that affect the resin specimens. The ceramic material is considered to be a resistance to wear and chemical erosion. It is considered a low adsorbed staining because it is hydrophobic material[8]. Hydrophobic materials, which generally show the least degree of chromatic change compared to hydrophilic resin teeth that contain polymethyl methacrylate monomer[33].

For this reason, there is research for the use a monomer such as hydroxyethyl methacrylate to manufacture resin-based teeth to increase the color stability of these teeth[39].

The resistance of ceramic crowns to the discoloration may be due to good chemical and hydrolytic stability when exposed to acid, which explains the higher color stability.

In comparison between the acrylic teeth and ceramics, the chromatic change in the acrylic teeth was so obvious than ceramic crowns were did not affect, this was in line with most comparative research between acrylic teeth and ceramics[8, 10, 13].

The limitation of this study has been overlooked the presence of saliva in the mouth, which causes washing of teeth after each exposure to beverages directly and there is no continuous exposure to dye for these long periods, as well as the neglecting of home care by mechanical and chemical cleaning procedures such as brushing and the use of cleaning solutions such as bleaching and peroxide cleanser by patient.The bacterial effect in the mouth has been ignored, which can convert the sugars in the Coca cola into acid, which increases the effects of chromatic changes.In the experiment the specimens were exposed to the Coca cola at room temperature, while the cola is usually drink while it is cool and the temperature changes may have a positive or negative effect on the amount of chromatic change, these should be considered areas in future studies.

CONCLUSIONS

Despite the limitations of this study, the following items were concluded:

- The shade of acrylic specimens was affected by aerated drink and became darker than initial shade before immersion.
- The shade of ceramic crowns was not altered after immersion in aerated drink.
- There are significant difference between acrylic teeth and ceramic crownsin shade dimensions and type of shade changed after experiment.

It is important to decrease the drinking of these beverages, because of their effects on the esthetic of artificial teeth as well as its effects on the general health of the body.

It is preferable to remove the dentures from the mouth during drinking of these staining drinks.

It is very important to consider the ceramics during treatment plan of the esthetic sensitive area, due to their durability and shade stability.

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