The effect of accelerated artificial aging on color change of three different types of composite (in vitro study)

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Abstract

The greater demand for esthetic in the modern life with the simplified bonding steps for composite filling increase its universal use but their gradual change in color over time make their replacement very important, the aim of this study is the comparison among different type of composite to see which type is the best color stability in the clinical work .

Material and method :30 samples of three different materials have been made ,the first group is 10 samples fabricated from Filtek z250 ,the second group is 10 samples fabricated from Filtek z250xt and the third group is 10 samples fabricated from z350xt .All the samples color parameters were measured before placing in accelerated weathering tester (time 0)then all the samples were placed in the accelerated weathering tester for 150 h and 300h then the color parameters were measured from which the change in color had been measured. Statistical analysis was performed by using ANOVA repeated measure test to see if there were any significant difference among the ΔE of experimental groups

Results : the results show that the z250 have the highest color stability as compared with other types of composite used in this study while the z350xt results show the lowest color stability also the result show that there's high significant difference among all groups among different time interval used in the study

Conclusion: the change in color above the clinically acceptable threshold (3.3) was seen in all types of composite used in this study and that the z 250xt shows the least change in color.

Key words: Composites, color stability, color change, aging

Introduction

composites are an important part and widely used in restorative treatment in modern esthetic dentistry, their appearance and bonding capacity make them suitable for esthetic areas [1]beside their simplified bonding steps, improved properties of composite resins, advances in their manufacturing process [2], minimal loss of tooth structure and ability to be directly placed without laboratory procedures contribute to their universal usage [3]

One of the major concerns in dentistry is to obtain the perfect color that resembles the color of natural teeth with artificial materials, so the demand for overall good color stability is increasing in the era of esthetic composite restorations [4]

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A good combination of the tooth color and initial color of the material before curing is an important clinical factor for a successful outcome [1], more importantly this combination must remain after the material is completely cured and throughout the life time of restoration [1], But one of the most important problems of composite restorations is their gradual color change and mismatch with the adjacent teeth over time. More than

80% of patients complain of color mismatch between their composite restorations and adjacent teeth [2]. In such cases, the main advantage of composites, their esthetic property, is lost and aesthetic failure happened which is one of the most common reason for the replacement of the restoration[3]

Several sources of discoloration have been suggested. External discoloration can be a result of plaque accumulation involving staining. Another reason is the degradation or staining within the superficial layer of resin composite related to dietary and smoking habits

Apparent color differences also may be related to surface roughness from polishing procedures and wear, as well as chemical degradation. Discoloration in the deeper layers of the material can be due to physico-chemical reactions within the material itself that are shade related. Tertiary amines contribute to discoloration, by a change in hue, from

whitish to yellowish appearance[4] so the color stability is an important factor for direct and indirect esthetic restorations and is fundamental to the success of the restorative treatment [5]. In order to evaluate the long-term color stability of direct composites, artificial accelerated aging was used to simulate the conditions to which the restorations will be exposed in the oral cavity for a relatively long time. The accelerated aging that uses ultraviolet light, humidity and temperature is most commonly used [6]

Material and method

In this experimental study 30 disc-shaped specimen measuring 10mm in diameter and 1mm in thickness were fabricated from Filtek z250, Filtek z250 xt and Filtek z350 xt , with a shade of A1 ,the properties of each type of composite was illustrated in table (1).

The discs were made by using a prefabricated plastic mold with a hole of 1 mm thickness and 10mm diameter ,placing the mold over a glass slide and after applying the composite inside covered with another piece of glass slide fig(1) and then each composite disc is light cured for 10 sec fig(2),then removed and polished .

After completing the specimens (10 disc for each type of composite) fig(3), Initial Color measurements were made by using of Easy shade advance spectrophotometer (Vita Zahnfabrik, Bad Sackinge, Germany) which consists of base unit and probe [7].

During color measurement the discs were placed on base with shade of A3 to simulate the natural underlying dental tissues [8] in a place were lighted by mixed light (florescent and sun light)which is fixed all over the measurements . Fig (4)

The single tooth mode was selected from the menu of Easy shade Advance, fig (5) then the device was calibrated according to manufacturer's instructions. The probe of the device was placed perpendicularly in the center of the disc in an intimate contact and the button of the device was pressed. The shade appeared in both Vita Classical and Vita 3D master shades and the color parameter (Hue, Chroma, lightness L*, a* and b*) displayed on the screen of the device fig (6).

Three measurements were made for each disc and then the mean of the three measurements were calculated[9] after that the specimen were subjected to accelerated aging by placing it in specialized holder inside Accelerated weathering tester (QUV/SPRAY) (Q-Lab Corporation, USA)fig(7)

Where the specimens were subjected to 150 cycles of aging, each cycle was two hours long. Within each cycle the specimens were exposed to ultraviolet light for 1 hour and 42 minutes and distilled water spray for 18 minutes and the temperature was 50^{o}C [10].

After the passage of 150 hours inside the tester color parameters of the specimens were measured again with Easy Shade Advance and returning back the specimen to the accelerated tester machine for another 150h to be totally 300 h and measured again fig(8).

-150 h in accelerated weathering tester is equal to 6 months intra orally [11]. And the 300 h in accelerated weathering machine correspond to one year [12].

The color difference (ΔE) was calculated from L*, a*, b* before and after aging for 150 and 300 hours using the following equation:

ΔE= [(ΔL*) 2+ (Δa*) 2+ (Δb*) 2]1/2

Where ΔE represent color difference, ΔL, Δa and Δb are the differences in color parameters of the specimens before and after aging [13].

Results

The change in the color stability (ΔE) of 30 samples were measured before aging and after 150 h and 300 h.

The means, Standard deviation and ANOVA repeated measures for ΔE of each groups (Filtek z250, Filtek z250 xt and Filtek z350 xt) listed in table (2)

From the table (2), it was found that there's high significant effect of the time and the interaction of (group*time) on variability of color

-in table (3) we see that there's high significant difference between each two groups in the time (0-150), but at the time (150-300) we see that there's non-significant difference between Z250 and Z250xt and there's high significant difference between Z250 and Z350xt and there's significant difference between Z250xt and Z350xt

In group Z250 we see there's high significant differences between the(0-150)and (150-300) time intervals and also there's high significant differences between the(0-150)and (0-300) time intervals while the results show anon significant differences between the (150-300) and (0-300) time intervals

The results for the groups of Z250xt and Z350xt represent a high significant difference among all times intervals.

The figure shows increasing in the color change with aging time for all groups (composite types).

The less change in color was seen in group z250 compared with other groups while z350xt has obtained the higher color change.

Discussion

The aim of this research is to study the effect 150 h and 300h inside Accelerated weathering tester that equalize 6 and 12 months intra orally on the color change of three different types of composite (Filtek z250,Filtek z250xt and Filtek z350xt) .

The results show that color stability decrease after accelerated aging , many factors effect on the color change among groups which may be external from the weathering tester like:

temperature ,light, water spray and time or it could be because of the internal factors which are related to the composition of each type of composite which include the volume and type of filler and resin matrix[14].

The particle size influence the color change through the change in the interface area between particles and the resin which by changing the particle size from micro to nano the interfacial area will increase and that will reflect on forming voids between them which may lead to a high quantity of water sorption , which is an important factor that effect on the color change these findings agree with[3].

By comparing among the materials used which had different particle size and volume fraction, we can see that larger particle size (z 250-microhybrid) showed a less color change while smaller particle size (z250xt – nanohybrid and z350xt –nanofill) showed increase in the color change

Filler content will also have an effect on the color change ,the composite with low volume friction of filler content will show a less color change (z250 -60%) and increased with increasing filler content (z 250xt-67% and z350xt-63%)

One of the constituents of the composite that effect on the color stability is the presence of TEGDEMA resin monomer in some types that increase water sorption because of its higher degree polymerization , this water sorption lead to voids inside the matrix or matrix filler interface that will cause penetration of fluids inside and further destruction

TEGDEMA and PEGDEMA in the resin composition of the z350xtwhich have a hydrophilic nature that effect on the water sorption of the material during time make the material more color change[15]

The results slowed that z250 had the least color change and this may be due to the composition of this type of composite which have the highest volume fraction of resin that lead to a lower polymerization process with higher molecular weight of the polymer which may lead to less surface voids that act as a source of water sorption and by time this will reach a saturation state that will decrease the water sorption in the resin [16]

These findings were agreed with [2]and disagree[3], while the z350 xt showed the highest color change between the other two groups for all time intervals used in this research and these results disagree with[1]

Robert G. Craig and John M. Powersin 2002 stated that a value of ΔE of 3.3 is considered perceptible clinically which is exceeded in this study in all types of composites used

So Z250 have the favorable use as esthetic filling compared with the other materials used in this research and 300 h in the accelerator aging tester shows color change exceed the acceptable limit 3.3`

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Table (1) characteristics of the three composites resin

Material	Type	Manufacturing company	Color	constituents	Filler content (v%)
Filtek z250	Micro hybrid	3M ESPE	A1	Matrix:BISGMA, UDMA,BISEMA Filler:zirconia silica (0.01-3.5µm)	60%
Filtek z250xt	Nano hybrid	3M ESPE	A1	Matrix:BISGMA, UDMA,BISEMA, TEGDEMA, PEGDEMA Filler: 0.1-10 micron	67.8%
Filtek z350xt	nanofill	3M ESPE	A1	Matrix : BISGMA,UDMA,BISEMA, TEGDEMA, PEGDEMA Filler:zirconia particles (0.6-10 microns)	63.3%

Table (2): The mean, standard deviation of color stability among all group within times, and the effect of time and interaction of time and group**.**

Time	Group	Mean	±SD	Multivarite test (Wilks' lambda) of Time[1]		Multivarite test (Wilks' lambda) of Time*Group[2]	
				F	Sig.	F	Sig.
0-150hr	Z250	6.427	1.088	511.583	0.000	16.273	0.000
	Z250xt	11.612	1.425				
	Z350xt	14.974	1.646				
	Total	11.004	3.824				
150-300hr	Z250	13.714	2.511				
	Z250xt	16.392	2.898				
	Z350xt	21.475	6.743				
	Total	17.194	5.421				
0-300hr	Z250	13.537	1.523				
	Z250xt	26.731	1.770				
	Z350xt	29.293	1.781				
	Total	23.187	7.210				

Table (3) the mean, standard error and LSD for the color change of the three times for all groups

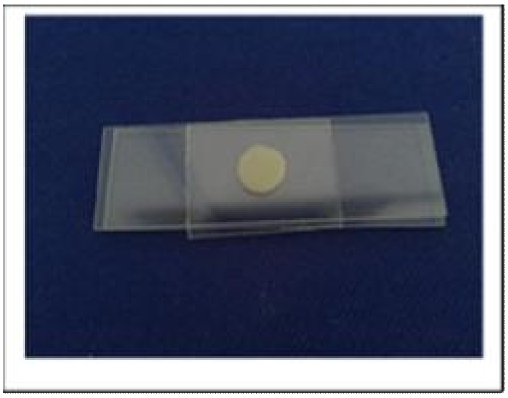
LSD Sig.	Sig.	F	SE	Mean	Group	Time
Z250XZ250xt=0.000	0.000	93.886	.444	6.427	Z250	0-150
Z250 xZ350xt=0.000			.444	11.612	Z250xt	
Z250xtxZ350xt=0.000			.444	14.974	Z350xt	
Z250XZ250xt=0.192	0.002	7.750	1.416	13.714	Z250	150-300
Z250XZ350xt=0.001			1.416	16.392	Z250xt	
Z250xtXZ350xt=0.017			1.416	21.475	Z350xt	
Z250XZ250xt=0.000	0.000	248.586	.536	13.537	Z250	0-300
Z250XZ350xt=0.000			.536	26.731	Z250xt	
Z250xtXZ350xt=0.002			.536	29.293	Z350xt	

Table (4) the mean, standard deviation, and LSD for each groups at the different time intervals

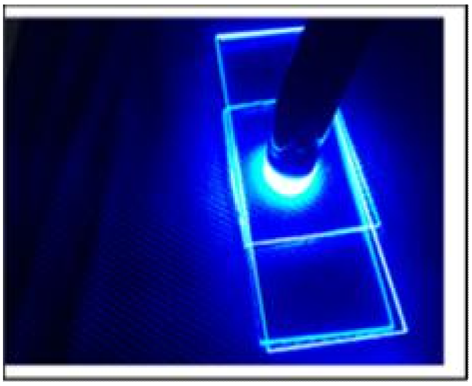
LSD Sig.	Sig.	F	SE	Mean	Time	Group
0-150 X 150-300=0.000	0.000	60.465	.444	6.427	0-150	Z250
0-150 X 0-300=0.000			1.416	13.714	150-300	
150-300 X 0-300=0.891			.536	13.537	0-300	
0-150 X 150-300=0.001	0.000	268.089	.444	11.612	0-150	Z250xt
0-150 X 0-300=0.000			1.416	16.392	150-300	
150-300 X 0-300=0.000			.536	26.731	0-300	
0-150 X 150-300=0.000	0.000	236.515	.444	14.974	0-150	Z350xt
0-150 X 0-300=0.000			1.416	21.475	150-300	
150-300 X 0-300=0.000			.536	29.293	0-300	

Table (5) show the Δa, Δb and ΔL for each type of composite for each time interval

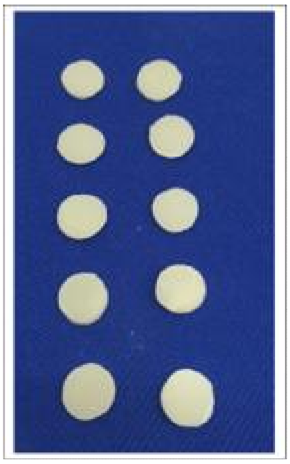
ΔL	Δb	Δa	Time	Type
-6.025	0.4625	0.575	0-150	Z250
-1.97639	13.09028	0.861111	0-300	
4.048611	12.62778	0.286111	150-300	
-5.83556	8.977778	2.406667	0-150	Z250XT
-9.74556	24.01778	4.276667	0-300	
-3.91	15.04	1.87	150-300	
-11.29	6.165556	3.043333	0-150	Z350XT
-10.62	26.69556	5.083333	0-300	
0.67	20.53	2.04	150-300	



Figure(1) constriction of the samples



Figure(1) light curing the composite



Figure(3) samples grouping

Figure (4) placing the sample over a base to simulate underlying dental tissue

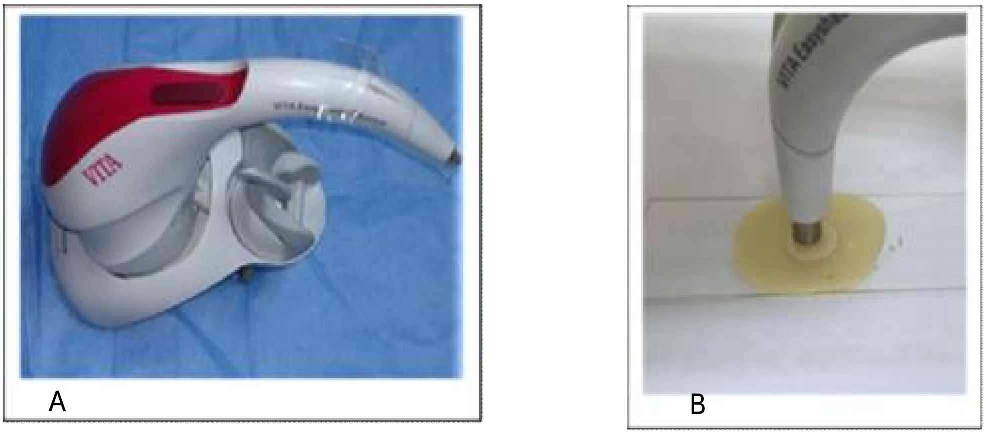
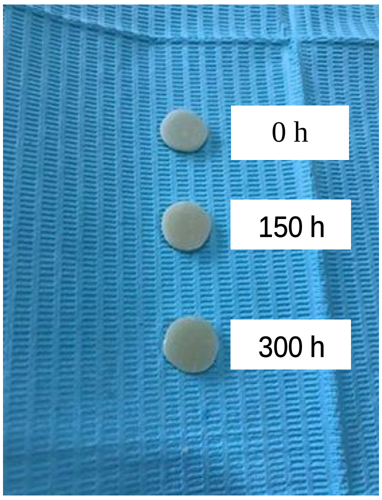


Figure (5)A Color measurement device, B device's probe perpendicular to the disc

Figure (6) Color parameters displayed on the screen of Easy shade.

Figure (7) Accelerated weathering tester



Figure(8) Filtek Z350xt before and after accelerated aging

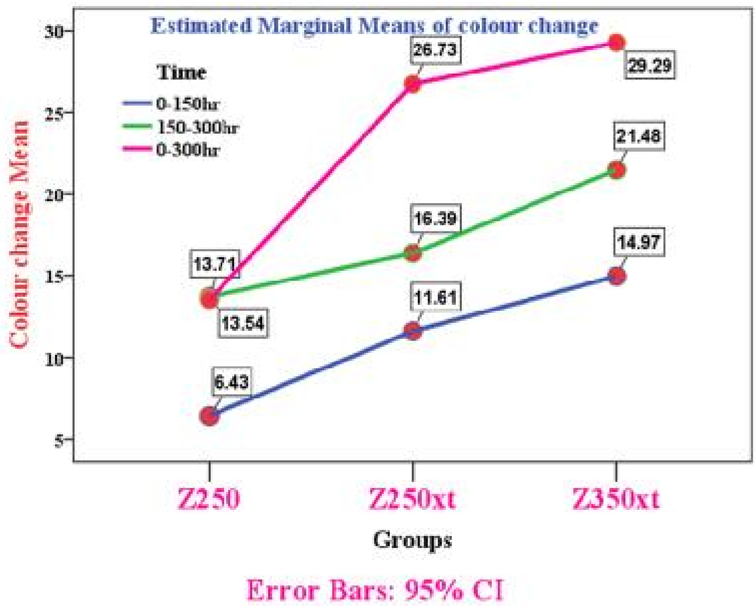


Figure (9) summarize the obtained result for the research work which is obtained from table (2), (3)and (4).