



Research Paper

In Vitro Evaluation of Fluorescence Stability of Different Composites and Dental Tissues Before And After Accelerated Aging

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Received 09 January, 2016; Accepted 24 February, 2016 © The author(s) 2015. Published with open access at www.questjournals.org

ABSTRACT:

Aim of study: To evaluate fluorescence stability of composite resins, with different filler sizes: Filtek Z250 (microhybrid), Filtek Z250XT (nanohybrid), Filtek Z350XT (nanofilled), before and after accelerated aging and compare them with human enamel-dentin specimens and to test the correlation between different filler sizes and the fluorescence intensity changes.

Materials and methods: one microhybrid, one nanohybrid with one nanofilled composite groups each of shade A2 tested. Ten human sound impacted third molars used to obtain enamel-dentin samples, these four groups submitted for fluorescence intensity measurement using fluorescence spectrophotometer (F96PRO, China) two times before and after accelerated aging using by weatherometer (QUV, Q-lab)

Results: One way ANOVA, Least significant difference test and paired samples T test used for statistical analysis. All four tested groups showed highly significant difference from each other both before aging and after aging in addition to that they all illustrated highly significant difference in the pattern of the fluorescence deterioration after aging.

Conclusions: It was concluded that dental composites with different fillers had different fluorescence intensity even if they manufactured by the same company, the artificial UV light aging adversely affected the fluorescence stability of dental composite and in general, the three filtek composites showed poor fluorescence stability compared to human teeth but each in different rate.

Clinical significance: human teeth with natural aging in the oral cavity, their fluorescence intensity increased with aging while dental composites' decreased which causing a problem in maintaining good esthetic results of the dental restorations.

Keywords: – fluorescence intensity, spectrophotometer, accelerated aging, QUV.

I. INTRODUCTION

Fluorescence (flə res'ə ns): the emission of radiation of a particular wavelength by certain substances as the result of absorption of radiation of a shorter wavelength (1). In 1911, Stubell used UV light to examine rabbits teeth and observed that teeth gave an intense blue color in matter of second to the eye; in 1928, Benidect mentioned that dentin fluoresced much more than enamel and cementum showed fluorescence similar to dentin but still with less intensity, Benidect also reported that carious dental tissues wither it was enamel or dentin eventually they had been losing their fluorescence and appeared black or dark brown under UV light illumination. Fluorometric investigations revealed that collagen crosslinked with the hydroxyapatite considered as the main fluorescing compound within the dental tissue and with the advancement of researches considering dental fluorescence, more dental fluorophores discovered (2). In the meanwhile composite resins fluoresced because of the luminescent (fluorophores) incorporated in, luminescent elements such as europium, cerium, and ytterbium (rare earths) oxides (3). Fluorescence of natural teeth had peaks in fluorescence in the range of wavelength (410-500nm), dental composites manufacturers nowadays claimed that the fluorophores they used, meant to allow composite restorations had the same fluorescent peaks as natural teeth giving whitish blue color in wavelength range between 410-500nm which favored the masking of restorations and consequently, the achievement of unnoticed restorations under UV illumination (4). The two null hypotheses for this study

included that fluorescence intensity would show no difference between different filler sizes of the tested composites compared with natural dentitions and the three composite resins would give off the same pattern of deterioration regarding fluorescent stability compared with natural dentitions.

II. MATERIALS AND METHODS

2.1. SAMPLE GROUPING:

Forty samples classified in four groups were investigated in this study. Three groups had composite samples each with different filler content and the fourth group consisted of ten human enamel-dentin specimens. These groups were:

1. Group A: ten human enamel-dentin specimens.
2. Group B: ten Filtek Z250 (3M, ESPE, microhybrid) discs.
3. Group C: ten Filtek Z250XT (3M, ESPE, nanohybrid) discs.
4. Group D: ten Filtek Z350XT (3M, ESPE, nonfilled) discs.

2.2. HUMAN TEETH SPECIMENS:

Ten freshly extracted sound human impacted mandibular third molars collected from young patients 18-25 years, from different health centers in Baghdad preserved in a lightproof container contained 0.1% thymol for 48 hours, then in distilled water at room temperature and during the storage period the dehydration of teeth avoided⁽⁵⁾. Before specimens obtained, the teeth tested for their shades using Easy shade (Vita), the probe tip held at 90° at the middle of buccal surface of the tooth. The teeth measured twice with an interval of 1 hour, at the middle of their buccal surface. Each tooth stabilized in a horizontal position on a white base with the tooth buccal surface⁽⁶⁾. (Ten of the collected impacted third molars with A2 shades were selected). The buccal surface was cut longitudinally with precision cutting machine (Struers, minitom) in to 2.5mm thick slice, which marked by pencil and reduced step by step in order to obtain enamel-dentin specimen had dimensions of (2×4× 4 mm). The thickness of the specimens, enamel and dentin checked with digital Vernier as in Fig (1)⁽⁷⁾.



Figure 1: 2mm Thick Enamel-Dentin Specimen.

2.3. Composite specimens' preparation:

Thirty composite specimens (2×2×4mm) built up by two silicone molds each one (1 x 4 x 4 mm). Dentin shade composite inserted into the mold by injecting directly from the composite tube, a transparent strip and glass slide positioned over the composite then 200 gm pressure applied over for one minutes to have uniform thickness and reduce air inclusions as shown in Fig (2)⁽⁸⁾.



Figure 2: 200 gm weight positioned on the top of composite to remove excess material.

Light curing carried out with a LED curing unit (Saab, China) with light intensity of 700 mW/cm² after being measured with LED light meter, then the top slide and the transparent strip were removed, and the second mold centered above the first mold for the insertion of the enamel shade composite, a new transparent strip and glass slide placed the same way with first composite layer followed by the weight pressure application on the surface prior to light curing for another twenty seconds, The specimens then removed from the mold as in fig (3) and kept in a lightproof container contained distilled water and stored at room temperature for 24 hours to ensure complete polymerization of composite until the fluorescence baseline measurements ⁽⁷⁾.

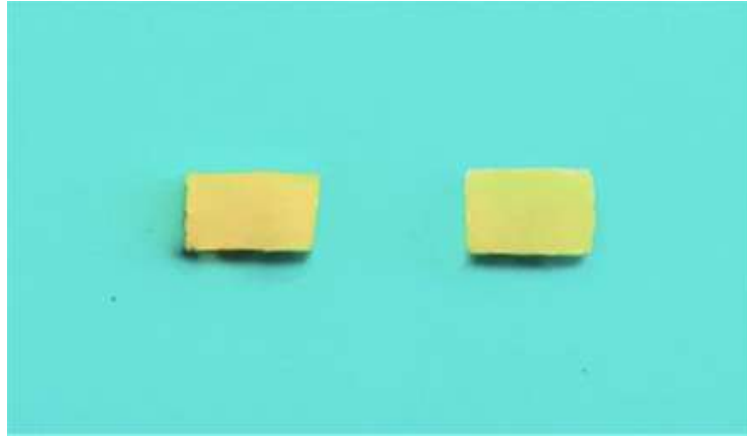


Figure 3: tooth sample on the right and composite sample on the left.

2.4. BASELINE FLUORESCENCE MEASUREMENTS:

Baseline fluorescence measurements were carried out using a fluorescence spectrophotometer (F96 (PRO Version), China). The excitation wavelength of 380 nm used to stimulate the specimens because teeth naturally got excited at this specific wavelength producing fluorescence peaks between 420-470nm, as a result samples tested at 380nm wavelength. The fluorescence readings at (420-470nm) range were taken since it was the wavelength range that the human teeth usually showed fluorescence intensity peaks ⁽⁹⁾.

2.5. Artificial UV light aging of samples:

All specimens subjected to accelerated aging by weatherometer (QUV, Q-lab). Continuous ultraviolet and visible-light cycles, cycles consisted of a temperature of 110°F equaled to (43.33° C) and intermittent distal water spray applied for 18 minutes every 2-hours period. The samples placed in the QUV weatherometer for 300 hours to age them one year in advance ⁽¹⁰⁾. After the aging process completion, all forty samples were tested again for their fluorescence intensity values as final measurement ⁽⁹⁾.

III. RESULTS

One-way ANOVA test at level of significance of (0.05). ANOVA test revealed a statistically highly significant difference among the four tested groups before aging. According to the paired samples T test can be concluded that all four groups showed highly significant difference (p=0.000) in the way that fluorescence intensity decreased after aging compared to their values before aging. All groups in general showed fluorescence intensity peaks between wavelengths 420nm-470nm especially at 440nm but with different fluorescent peak heights and areas as illustrated in Figures (4), (5), (6), also groups B, C and D had lower fluorescence intensity peaks height than Group A in both before and after aging.

Figure 4: Comparison of the Fluorescence Intensity Spectrum between Groups A And B Before and After Aging.

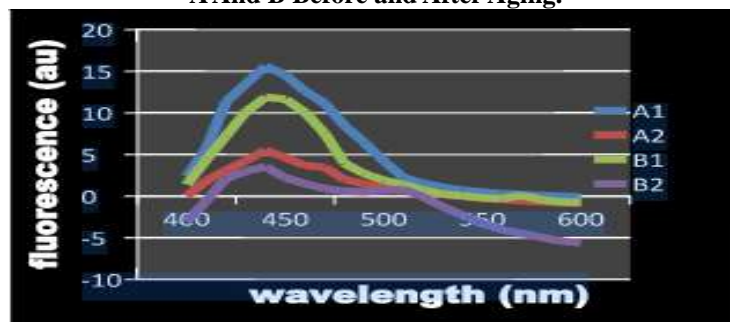


Figure 5: Comparison of the Fluorescence Intensity Spectrum between Groups A and C Before and After Aging.

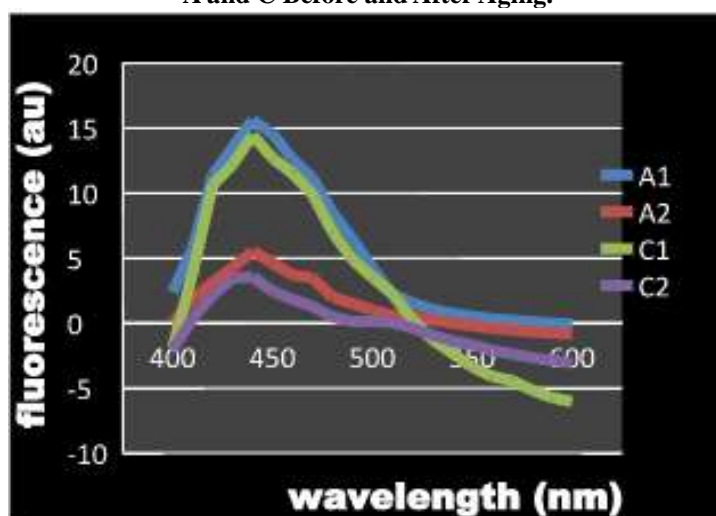
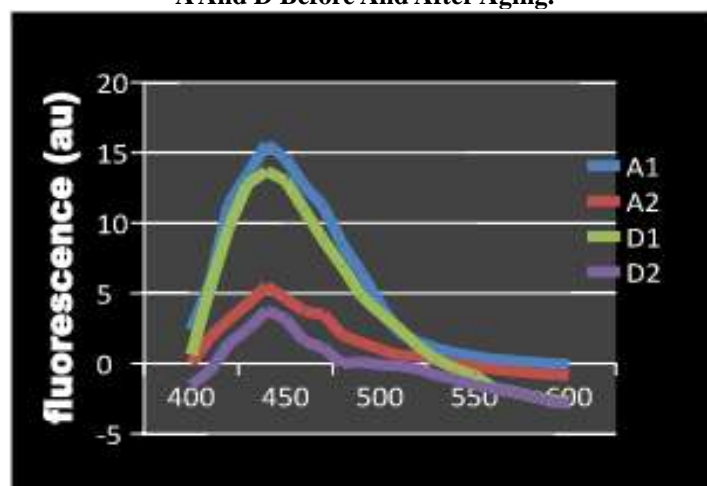


Figure (6): Comparison of the Fluorescence Intensity Spectrum Between Groups A And D Before And After Aging.



The difference in fluorescence intensity means of each group had been shown in Table 1 which also included the standard deviation of the fluorescence means difference in addition to the percentage of fluorescence reduction, this table revealed that group D had the highest percentage of decrease in fluorescence intensity after aging followed by group C then group B and the group A showed the lowest percentage of reduction in fluorescence intensity after aging.

Table 3-7: mean of fluorescence mean differences between the four groups before and after aging with standard deviation and the percentage of change in each group:

<i>Groups</i>	<i>Mean of fluorescence intensity difference</i>	<i>±SD</i>	<i>PERCENTAGE OF CHANGE Δ(%)</i>
<i>Group A</i>	-53.6	±8.339911	-68.487%
<i>Group B</i>	-45.4	±2.416711	-77.47%
<i>Group C</i>	-56.7	±3.594636	-79.52%
<i>Group D</i>	-55.2	±2.911042	-80.23%

IV. DISCUSSION

Fluorescence of dental composite caused definitely by luminophores or what so-called fluorophores incorporated in the composite materials but till now dental composites companies don't reveal what type of fluorophores they used or where they incorporated them in resin matrix or filler (11). There were studies investigated the fluorescence of dental composite resins as examples, Park et al., 2006, added fluorescent whitening agent to experimental light cure resin matrices and found that fluorescence emission influenced by the type of resin matrix. Changes in the color and fluorescence between Flowable and universal resin composites tested based on the assumption that the filler content would play a role in the color and fluorescence of dental composites and all universal resin composites and only two of the Flowable composite showed fluorescence peaks (13). In this study as baseline measurement this difference in fluorescence intensity between composite groups could be explained by the difference in the amount of fluorophores contained in originally although they were all manufactured by the same company, but hence the fluorophores content differed not only between companies but also between different shades in the same brand (7). Fluorescence values readings could be also affected by the absorption coefficient of the composite materials since the filler particle size and distribution were not the same between the composite groups (13). The difference in fluorescence intensity values between composites in this study also reported in other studies (7) (14) (15). The components of the composite should be analyzed qualitatively and quantitatively regarding resin matrix and filler content, type, size, shape, distribution in order to take these variables in consideration during fluorescence intensity comparison in future studies. All groups showed decline in fluorescence intensity means values but the decrease was higher with dental composite groups compared to the control group which showed resistance to artificial aging, this came in agreement with other studies (16) (17) (18). Many authors (7) (9) (16) explained this drop in fluorescence intensity as result of degradation of resin matrix and they assumed that the fluorophores incorporated in the resin matrix of composite since the UV light aging affected the resin matrix the most by its photo-oxidative capacities that caused cleavage of the double carbon groups degrading the polymeric structures of the resin matrix. The artificial aging in general could not be related to physiological aging regarding human teeth since human dentin overlaid more collagen and organic matrix with the increase in the chronological age which resulted in enhancing the fluorescence intensity of teeth with aging (9). There was significant difference comparing the means difference between before aging and after aging according to paired samples T test which implied that the filler content had an influence in the fluorescence intensity. As a result according to this study the composite with the largest particle size and more inter-filler spaces (microhybrid composite) showed more fluorescence stability than the nanohybrid which had smaller particle sized filler and less inter-filler spaces and the nanohybrid composite in return showed fluorescence stability better than nanofilled composite which was denser by including less interstitial spaces between the filler particles. The two null hypotheses rejected that first the three filtek groups showed a difference in fluorescence intensity from the human teeth before aging and secondly they were significantly different in the pattern of fluorescence deterioration after aging.

V. CONCLUSION

Within the limitation of this study it can be concluded that

1. Dental composites with different filler content had different fluorescence intensity values even if they were manufactured by the same company.
2. The artificial UV light aging adversely affected the fluorescence stability of dental composite and with less damage to human teeth.
3. The nanofilled composite showed the highest percentage of change and microhybrid composite showed the lowest percentage of change while nanohybrid showed intermediate fluorescence stability compared with other two groups, which might implied that there is a correlation between the inter-filler spaces and fluorescence stability.

But as a whole the three filtek composites showed poor fluorescence stability in comparison with human teeth which might endangered the whole esthetic outcome of the restorative work especially in anterior teeth. As a clinical significance, measurements of the fluorescence of patient teeth might become a requirement so that clinicians could choose composite material with similar fluorescence emission.

REFERENCES

- [1]. Mosby's Dental Dictionary. Fluorescence, 2nd edition. Elsevier. (2008).
- [2]. Lee Y, Lu H, Powers M. Fluorescence of layered resin composites. *J Esthet Restor Dent*. 2005; 17:93–100.
- [3]. Gamborena I, Blatz M. Fluorescence—mimicking nature for ultimate esthetics in implant dentistry. *Quintessence of dental technology*. 2011; volume 34, p7.
- [4]. Alpino P, Pereira J, Svizero N, Rueggeberg F, Pashley D. Use of fluorescent compounds in assessing bonded resin-based restorations: A literature review. *Journal of dentistry*. 2006; 34:623- 634.
- [5]. Aguiar S, Carlino G, Lins T, Bagnato M, De-Souza P, Panzeri H. Evaluation of Fluorescence of Dental Composites using Contrast Ratios to Adjacent Tooth Structure: A Pilot Study. *J Esthet Restor Dent*. 2007; 19:199–207.
- [6]. Lagouvardos E, Aggeliki G, Fougia A, Sofia A, Polyzois D. Repeatability and interdevice reliability of two portable color selection devices in matching and measuring tooth color. *The Journal of Prosthetic Dentistry*. 2009; 101; 40-5.

- [7]. Jablonski T, Takahashi M, Brum R, Rodrigo R, Souza M. Comparative study of the fluorescence intensity of dental composites and human teeth submitted to artificial aging. *General Dentistry*. 2014; 62(1):37-41.
- [8]. Nogueira C; Borsatto M; Souza-Zaroni W, Ramos R, Dibb R. Microhardness of composite resins at different depths varying the post-irradiation time. *J. Appl. Oral Sci.* 2007; 15(4):305-9.
- [9]. Takahashi MK, Vieira S, Rached R, Almeida J, Aguiar M., Souza E. Fluorescence Intensity of Resin Composites and Dental Tissues Before and After Accelerated Aging: A Comparative Study. *Operative Dentistry*. 2008; 33-2, 189-195.
- [10]. [Gulfem E](#), [Nagas I](#). Color Stability of Silicone or Acrylic Denture Liners: An in Vitro Investigation. *Eur J Dent*. 2007 Jul; 1(3): 144–151.
- [11]. Uo M, Okamoto M, Watari F, Tani K, Morita M, Shintani. Rare earth oxide-containing fluorescent glass filler for composite resin. *Dent Mater J*. 2005; 24(1):49-52.
- [12]. Park M, Lee Y, Lim B. Influence of fluorescent whitening agent on the fluorescent emission of resin composites. *Dent Mater*. 2007 Jun;23(6):731-5.
- [13]. Bin Yu, Yong L. Differences in color, translucency and fluorescence between flowable and universal resin composites. *J Dent*. 2008;36:840–846.
- [14]. Lim B, Lee Y. Fluorescent emission of varied shades of resin composites. *Dent Mater* 2007; 23: 1262-1268.
- [15]. Lefever D, Mayoral J, Mercade M, Basilio J, Roig M. Optical integration and fluorescence: a comparison among restorative materials with spectrophotometric analysis. *Quintessence Int*. 2010; 41: 837-844.
- [16]. Lee Y, Lu H, Powers J. Changes in opalescence and fluorescence properties of resin composites after accelerated aging. *Dent Mater*. 2006; 22(7):653-660.
- [17]. Meller C, Klein C. Fluorescence properties of commercial composite resin restorative materials in dentistry. *Dental Materials Journal* 2012; 31(6): 916–923
- [18]. Casali L, Pessine F, Franca F, Florio F, Basting R. in vitro evaluation of longevity of composite resin fluorescence after storage and repolishing. *International journal of clinical dentistry*; 2012, 5:4, P386.