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ORIGINAL RESEARCH

Fluorescence Level of Composites assessed by Computer Processing of Digital Images: ScanWhite©

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ABSTRACT

The human dentition is naturally translucent, opalescent and fluorescent. Differences between the level of fluorescence of tooth structure and restorative materials may result in distinct metameric properties and consequently perceptible disparate esthetic behavior, which impairs the esthetic result of the restorations, frustrating both patients and staff. In this study, we evaluated the level of fluorescence of different composites (Durafill in tones A2 (Du), Charisma in tones A2 (Ch), Venus in tone A2 (Ve), Opallis enamel and dentin in tones A2 (OPD and OPE), Point 4 in tones A2 (P4), Z100 in tones A2 (Z1), Z250 in tones A2 (Z2), Te-Econom in tones A2 (TE), Tetric Ceram in tones A2 (TC), Tetric Ceram N in tones A1, A2, A4 (TN1, TN2, TN4), Four seasons enamel and dentin in tones A2 (and 4SD 4SE), Empress Direct enamel and dentin in tones A2 (EDE and EDD) and Brilliant in tones A2 (Br)). Cylindrical specimens were prepared, coded and photographed in a standardized manner with a Canon EOS digital camera (400 ISO, 2.8 aperture and 1/30 speed), in a dark environment under the action of UV light (25 W). The images were analyzed with the software ScanWhite©-DMC/Darwin systems. The results showed statistical differences between the groups ($p < 0.05$), and between these same groups and the average fluorescence of the dentition of young (18 to 25 years) and adults (40 to 45 years) taken as control. It can be concluded that: Composites Z100, Z250 (3M ESPE) and Point 4 (Kerr) do not match with the fluorescence of human dentition and the fluorescence of the materials was found to be affected by their own tone.

Keywords: Fluorescence, Composite resins, Image processing Computer-assisted.

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INTRODUCTION

Over the past years, resin composites have evolved as esthetic restorative material, incorporating various optical characteristics of natural tooth structure like fluorescence, opalescence, different colors of translucence, different levels of opacity, special effects, specific colors and modifiers value to allow the dentist to perform imperceptible restorations.

In order to reach predictable esthetic results and a high level of reproducibility of the original characteristics of teeth, manufacturers are continually launching new resin composites that demand the simulation of the optical properties of natural teeth.[1]

The restorative materials do not present in its basic components the property of fluorescence, so the restorations appear darker compared to the natural dentition. To solve this problem manufacturers added agents luminophores, such as europium, terbium, ytterbium and cerium, satisfactorily reproducing the fluorescence of natural teeth for some composites.[2,3]

By definition, fluorescence is the absorption of light by a substance and the emission of light in a longer wavelength within 10 to 18 seconds of activation.[4] In dentistry, it has been assumed that fluorescence is the absorption of a substance of ultraviolet (UV) light (black light) and the emission of a visible light in the bluish spectrum.[5,6]

The natural teeth emit a strong blue fluorescence under the action of the UV light. This property makes teeth whiter and brighter in daylight.[7] Esthetic restorative materials should have similar fluorescence as compared to the teeth, or esthetic qualities of the restorations will be compromised under UV light,[8] and other conditions under which these materials are exposed to UV wavelengths as sunlight.

Reaching a perfect color match under varied illuminations, including fluorescence-inducing light sources, is extremely difficult,[9,10] which can be facilitated if the clinician knows the different optic behaviors of resins composites when irradiated by black light.

Therefore, the knowledge of different properties of resins composites allows more satisfying results of esthetic restorations, producing a mimetic of the natural dentition and restoration even in different means of illumination.[11]

Thus, the study aimed to assess the fluorescence level of composite resins determined by computer processing of digital images with the software ScanWhite©-DMC/Darwin systems.

MATERIALS AND METHODS

Three specimens were made for each material (Table 1). The specimens were obtained from a rigid standardized plastic matrix, with 5 mm in diameter and 2 mm high.

The specimens were identified and stored individually in sealed plastic containers at room temperature. They were photographed in a standardized manner with a Canon EOS camera digital (400 ISO, 2.8 aperture and 1/30 speed) in a dark environment under UV light (25 W) in an especially

Table 1: Trademarks and manufacturers of composite resins

Composite resin (code)	*Manufacturers*
Durafil A2 (Du)	Heraeus Kulzer
Charisma A2 (Ch)	Heraeus Kulzer
Venus A2 (Ve)	Heraeus Kulzer
Opallis enamel A2 (OPe)	FGM
Opallis dentin A2 (OPd)	FGM
Point 4 A2 (P4)	Kerr
Z100 A2 (Z1)	3M ESPE
Z250 A2 (Z2)	3M ESPE
Te-Econom A2 (TE)	Ivoclar Vivadent
Tetric Ceram A2 (TC)	Ivoclar Vivadent
Tetric N-Ceram A1 (TN)	Ivoclar Vivadent
Tetric N-Ceram A2 (TN)	Ivoclar Vivadent
Tetric N-Ceram A4 (TN)	Ivoclar Vivadent
Four Seasons enamel A2 (4Se)	Ivoclar Vivadent
Four Seasons dentin A2 (4Sd)	Ivoclar Vivadent
Empress direct enamel A2 (EDe)	Ivoclar Vivadent
Empress direct dentin A2 (EDd)	Ivoclar Vivadent
Brilliant New Line A2 (Br)	Coltène Whaledent

designed device consisting of a styrofoam box (50 cm each side) that allowed the diffuse reflection of UV irradiance of two black light bulbs of 25W. A slit was maintained between the two bulbs through which the photographs were obtained, and the front face of the box was kept open to allow proper positioning of the resin specimens.

The samples were placed at 58 cm from the objective Canon 100 mm/2.8 macro.

The images were coded and the difference between the levels of fluorescence was analyzed where each condition was determined by digital image processing computer-aided software ScanWhite© DMC/Darwin systems, Brazil (Fig. 1). This automatically determines the difference between the values of three color channels R, G and B of the images and displays the values in the unit itself named Tom (T).

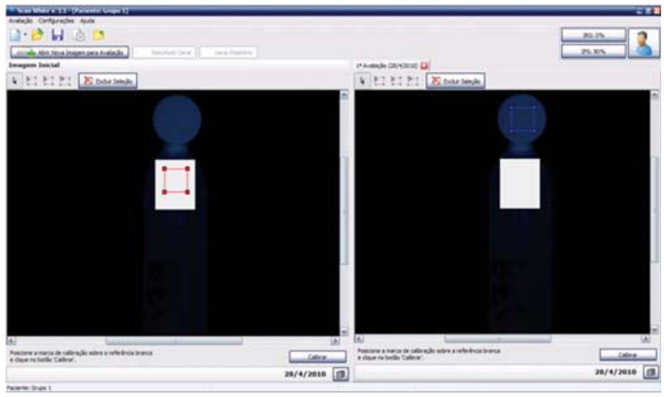

Fig. 1: Analysis by computer processing—ScanWhite©

The human dentition fluorescence of both adult and young people was also studied through computer processing of digital images using the same methodology in order to characterize '*in vivo*' the influence of age. The mean values obtained were used to compare the approach of the degree of fluorescence of resin composites.

RESULTS

Table 2 shows the mean values, standard deviation and coefficient of variation of the data grouped by age (young human teeth—HJ and adult human teeth—HA) and the different coded composite resins.

The analysis of variance and Fisher's exact $p < 0.05$ showed a statistically significant difference between the groups (Fig. 2). The average fluorescence of the dentition of the young (18 to 25 years) and the adults (40 to 45 years) were taken as control.

Table 2: Mean, standard deviation and coefficient of variation of fluorescence

	N	*Mean*	*Standard deviation*	*Coef. of variation*	*Minimum*	*Maximum*
HJ	3	–314.333	17.7858	–5.65825%	–327	–294
Du	3	–318.0	17.5784	–5.5278%	–338	–305
Ch	3	–336.333	2.88675	–0.858301%	–338	–333
Ve	3	–334.667	8.62168	–2.5762%	–344	–327
OPE	3	–342.0	3.4641	–1.0129%	–344	–338
OPD	3	–344.0	14.9332	–4.34104%	–361	–333
P4	3	–277.333	9.2376	–3.33087%	–288	–272
Z1	3	–412.667	2.88675	–0.699536%	–416	–411
Z2	3	–416.333	5.50757	–1.32288%	–422	–411
TE	3	–329.0	21.0	–6.38298%	–344	–305
TC	3	–320.0	15.5885	–4.87139%	–338	–311
TN1	3	–283.0	19.0526	–6.73235%	–305	–272
TN2	3	–299.667	24.0901	–8.03897%	–316	–272
TN4	3	–346.0	3.4641	–1.00119%	–350	–344
4SE	3	–301.667	2.88675	–0.956934%	–305	–300
4SD	3	–290.333	6.35085	–2.18744%	–294	–283
EDE	3	–292.333	8.62168	–2.94926%	–300	–283
EDD	3	–288.333	5.50757	–1.91014%	–294	–283
BR	3	–336.333	2.88675	–0.858301%	–338	–333
HA	3	–325.333	11.3725	–3.49564%	–338	–316
Total	60	–325.383	38.07	–11.7%	–422	–272

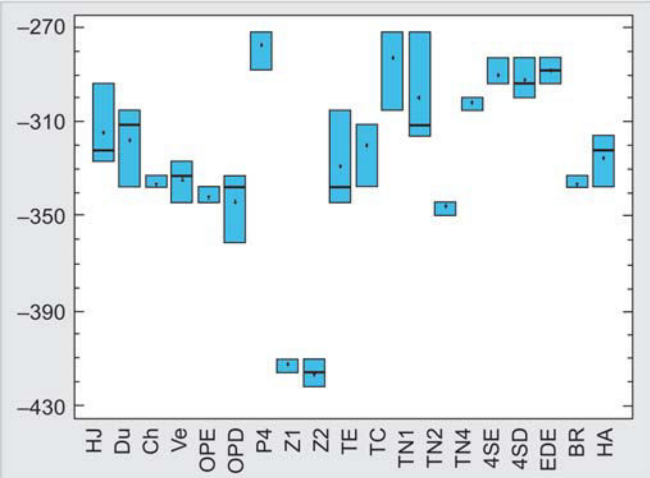

Fig. 2: Analysis by computer processing—ScanWhite©

DISCUSSION

The fluorescence of dental restorative materials has been studied by some researchers.[9,12,13] Differences in optical behavior under different light sources can be easily perceived by human eye and restorative materials do not adequately reproduce the dental fluorescence.

Composites with low fluorescence can bring esthetic damage depending on the patient's profile and the area to be restored. Already resins with high fluorescence in relation to tooth structure have clinical merit, because they suffer some kind of extrinsic staining may have decreased the fluorescence, and are advantageous when one wants to mask a darkened dentin.[8,14]

To date, the fluorescent components of composites are not yet well known until now. Studies[9,15,16] have investigated the possibility of incorporating substances termed luminophores in the resin composition in order to increase the intensity of fluorescence.

The effect of fluorescence can be obtained by different light sources, including UV rays from sunlight. In the dental fluorescence, the rays reach the dentin, which has a higher amount of organic photosensitive pigment with UV spectrum, exciting the photosensitivity of the dentin and emitting fluorescence.[17] The natural sunlight, lamp flashes for photography, black light bulbs and lamps contain UV radiation with similar wavelength, ranging between 350 to 400 nm.[3,18]

When the fluorescence of different composite resins were compared, they were found to be less intense for both Filtek™ Z100 (3M ESPE) and Filtek™ Z250 (3M ESPE), which can cause harm to esthetic restoration. On the other hand, Point 4 (Kerr) resin showed a higher intensity of fluorescence, being advantageous when you want to mask a darkened dentin.[8,14] Compared in terms of natural dentition, the resins that are closest to the values of fluorescence are Durafill, Tetric Ceram and Te-Econom. These values give the teeth a more white impression.

For this reason, a better understanding of the dental fluorescence behavior for different interactions of light will be of invaluable aid to researchers and clinicians alike. Thus, the digital images and computer processing with the software ScanWhite©—DMC/Darwin systems, São Carlos, Brazil, can be used as a scientific method for evaluating the optical properties of restorative materials.

Most of the studies that relate to the human dentition fluorescence have been performed on extracted teeth, bringing different results compared to those observed in '*in vivo*' conditions,[19-21] such as the parameters used in this study, where the natural dentition of both young and adult people were evaluated the same way as the composites resins, indicating the importance of elucidating the level of fluorescence of human teeth in the real conditions benchmarking with restorative materials.

CONCLUSION

It can be concluded that:

1. The resins Z100, Z250 (3M ESPE) and Point 4 (Kerr) do not match with the fluorescence of human dentition.
2. The fluorescence of the materials was found to be affected by their own tone.

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