Considerations Regarding the Optical Properties of the Composite Resin Restorative Materials

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ABSTRACT The purpose of this study has been to investigate the effects of certain substances frequently used in alimentation on the color stability of the composite resin restorative materials. The research hypothesis was that color stability of the composite resin is affected by the type of composite material used and by the polishing procedure. 14 samples of 5X15X2mm have been prepared from seven universal light curing restorative composite resins. The materials have manipulated and cured using LA 500 Blue Light lamp. A first color determination was done before the introduction of the samples in the dyeing agent with the help of an Easy Shade device. The samples have been splitted into two lots each with seven samples. The samples from the first lot have been sectioned into three equal segments. The samples from the second lot have also been sectioned into three equal segments, and in addition to the previous group, their exterior surfaces were processed with a diamond burr. For each type of composite we have introduced a sample in one of the three chosen dyes: red alimentary colorant, coffee and red wine. The color of the samples has been determined again using the Vita Easy Shade device. From clinical point of view the results of this study shows that there are three important factors that matter when we talk about durable aesthetic results: the type of composite resin used for the restoration, the finishing and polishing procedures and the patients’ alimentation habits. The composite resins with a good representation of the anorganic structure are easier to be polished, therefore they have only slight color modifications. Using plastic matrices for shaping the exterior surface of the restoration is the best solution for obtaining a very smooth surface. The most significant color modifications have been done by the red wine. Coffee and to a smaller extent the red alimentary colorant have modified the color of the restoration material in a smaller degree.

KEY WORDS composite resins, finishing procedures, dyeing agents

Introduction

The high demand for dental aesthetics has been linked to a fast growing development of new resin based restorative materials. The clinical performances of the composite resins are excellent, more so if we compare them with the preceding restorative systems (1). Nonetheless, restorative composite materials on the market have different composition, surface texture and chemical stability (2). The aesthetics and the longevity of the restoration depend on a good finishing and polishing procedures (3). The roughness and surface integrity as well as the physical and chemical properties of the material can influence the maintaining of the composite resins color or its modification (4).

The purpose of this study was to investigate the effect of certain substances frequently used in alimentation on the stability of the color. We have tried to establish if the stability of the composite resin’s color is affected by the type of composite material used and by the type of polishing procedure used.

Materials and methods

14 samples each measuring 5X15X2mm (fig 1&2) have been prepared out of seven universal restorative light curing composite resins for physionogmic restorations in the anterior and posterior area (Herculite, Fulfil Extra, Filtek Z250, Tetric, Peklite, Te-Econom, Valux) (fig.3).
The composite material sample length (15 mm)

For manufacturing the samples we have used extemporaneously shaped molds made from modeling paste. Before using the composite material we foiled the mold using an aluminum foil for the composite material not to adhere after light curing. The molds have been filled with composite resin using a spatula (fig.4) and the exterior surface has been shaped with the help of a transparent celluloid strip in order to obtain a smooth surface (fig.5).

The materials have been manipulated and cured according to the manufacturer’s specifications using a LA 500 Blue Light lamp (wavelength between 400 to 500nm) (fig. 6).

The color determination has been done using an Easy Shade device. Before each determination the device has been recalibrated. A ceramic block of known color is used for calibration. After calibrating the device, the handpiece reads the color when it is applied on the surface of the material (fig. 7&8).
The first color determination has been done before introducing the samples in the dyeing agent.

The samples have been split into two lots each with seven samples.

The samples from the first lot have been sectioned into three equal segments measuring 5X5X2mm resulting in three samples for each type of composite. For each type of composite we have introduced a sample in one of the three chosen dyes: red alimentary colorant, coffee and red wine.

The samples from the second lot have also been sectioned into three equal segments measuring 5X5X2mm resulting in three samples for each type of composite material. Unlike the first lot, the exterior surfaces of these samples have been processed with a diamond burr in order to obtain a surface resembling the surface of the composite restorations in the oral cavity after burr finishing. For every type of composite material we have introduced a sample in each of the chosen dyes: red alimentary colorant, coffee and red wine.

The samples have been introduced in the dyeing agents for ten days. Afterwards the samples have been taken out of the dyeing agent and washed with distilled water and then dried.

The color has been determined again with the Vita Easy Shade device.

**Results**

By determining the color of the samples from the first lot with the Easy Shade device we have reached the following results: (table 1)

**Table 1 The color of the samples from the first lot determined with the Vita Easy Shade device**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Product</th>
<th>Manufacturer</th>
<th>Color</th>
<th>Initial Easy Shade color</th>
<th>Easy Shade color after red alimentary colorant exposure</th>
<th>Easy Shade color after coffee exposure</th>
<th>Easy Shade color after red wine exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>HERCULITE XRV</td>
<td>KERR</td>
<td>A2</td>
<td>4M1</td>
<td>4,5M1</td>
<td>4,5 M1,5</td>
<td>5M1</td>
</tr>
<tr>
<td>2A</td>
<td>FULL FIL EXTRA</td>
<td>DENTSPLY DETRAY</td>
<td>A2</td>
<td>4M1</td>
<td>4,5M1</td>
<td>4R1,5</td>
<td>4,5M1,5</td>
</tr>
<tr>
<td>3A</td>
<td>FILTEK Z250</td>
<td>3M ESPE</td>
<td>UD</td>
<td>2,5M3</td>
<td>3M3</td>
<td>4M3</td>
<td>4M3</td>
</tr>
<tr>
<td>4A</td>
<td>TETRIC</td>
<td>IVOCLEAR VIVADENT</td>
<td>A1</td>
<td>3,5L1,5</td>
<td>3,5L1,5</td>
<td>4L1,5</td>
<td>4L2</td>
</tr>
<tr>
<td>5A</td>
<td>PEKALITE</td>
<td>HERAEUS</td>
<td>A1</td>
<td>3,5M1</td>
<td>3,5M1</td>
<td>4,5M2</td>
<td>4,5M2,5</td>
</tr>
<tr>
<td>6A</td>
<td>TE-ECONOM</td>
<td>IVOCLEAR VIVADENT</td>
<td>A3,5</td>
<td>4,5M2</td>
<td>4,5M2</td>
<td>4,5M2,5</td>
<td>5M1,5</td>
</tr>
<tr>
<td>7A</td>
<td>VALUX</td>
<td>3M ESPE</td>
<td>B2</td>
<td>3,5M1</td>
<td>3,5M1</td>
<td>4M1</td>
<td>5M3</td>
</tr>
</tbody>
</table>

For all the samples from the first lot the most powerful dyeing agent was the red wine and the least powerful, with insignificant color modifications was the red alimentary colorant.

By determining the color of the samples from the second lot with Easy Shade we have reached the following results: (table 2)

**Table 2 The color of the samples from the second lot determined with the Vita Easy Shade device**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Product</th>
<th>Manufacturer</th>
<th>Color</th>
<th>Initial Easy Shade color</th>
<th>Easy Shade color after red alimentary colorant exposure</th>
<th>Easy Shade color after coffee exposure</th>
<th>Easy Shade color after red wine exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B</td>
<td>HERCULITE XRV</td>
<td>KERR</td>
<td>A2</td>
<td>4M1</td>
<td>5M1</td>
<td>4L2</td>
<td>5M2</td>
</tr>
<tr>
<td>2B</td>
<td>FULL FIL EXTRA</td>
<td>DENTSPLY DETRAY</td>
<td>A2</td>
<td>4M1</td>
<td>4,5M2</td>
<td>4R2</td>
<td>4,5M2,5</td>
</tr>
<tr>
<td>3B</td>
<td>FILTEK Z250</td>
<td>3M ESPE</td>
<td>UD</td>
<td>2,5M3</td>
<td>4M2,5</td>
<td>4M3</td>
<td>4M3</td>
</tr>
<tr>
<td>4B</td>
<td>TETRIC</td>
<td>IVOCLEAR VIVADENT</td>
<td>A1</td>
<td>3,5L1,5</td>
<td>3,5L1,5</td>
<td>4L2</td>
<td>4L2,5</td>
</tr>
<tr>
<td>5B</td>
<td>PEKALITE</td>
<td>HERAEUS</td>
<td>A1</td>
<td>3,5M1</td>
<td>3,5M2</td>
<td>4,5M2</td>
<td>5M2,5</td>
</tr>
<tr>
<td>6B</td>
<td>TE-ECONOM</td>
<td>IVOCLEAR VIVADENT</td>
<td>A3,5</td>
<td>4,5M2</td>
<td>4,5M2,5</td>
<td>4,5M3</td>
<td>5M2</td>
</tr>
<tr>
<td>7B</td>
<td>VALUX</td>
<td>3M ESPE</td>
<td>B2</td>
<td>3,5M1</td>
<td>4M2</td>
<td>4L1,5</td>
<td>5M3</td>
</tr>
</tbody>
</table>

For the samples in the second lot the most powerful dyeing agent was also the red wine but the other dyeing agents produced some noticeable modifications too.

**DISCUSSION**

The color change of the composite restoration material in the anterior area is one of the main...
factors that determine the patients to ask for a replacement (5).

Many authors have been interested in evaluating the color stability of different physionomic restorative materials (6,7).

Color modifications of restorative materials can be evaluated visually or by instrumental techniques. The visual method, although the most commonly used, has a lot of disadvantages because of the subjective nature of the determination.

The instrumental methods are objective methods and there are represented by colorimetry, spectrophotometry and digital image analysis (8).

Natural tooth color description is based on the Munsell system, so when we talk about their color we must define it in terms like shade, saturation and brightness (9).

The Easy Shade device used in the study is a spectrophotometer destined for evaluating the color characteristics of teeth. When determining the color, the device uses three spectrophotometers: one that monitors the light source and two other that measure the light dispersion into the depth of the dental structures. The device can be set to determine the color of the teeth and dental materials too.

This device determines the color using a special coding known as Vitapan 3D Master (VITA) that is more precise in tooth color analysis than Vitapan Classical (10).

From a clinical point of view the results of this study demonstrates that for obtaining durable aesthetic results there are three factors to be taken in consideration: the restorative composite resin type used, the finishing and polishing procedure and the patient’s alimentation habits.

The structure of a composite resin and especially the characteristics of the anorganic particles have a direct influence on the degree of roughness of the restoration’s surface and on the risk of extrinsic coloration occurrence (11). Composite resins with a good representation of the anorganic structure are easier to finish and polish having only slight color modifications when exposed to different dyeing agents. It is also very important the type of filling particles, the presence of large diameter filling particles at the surface of the restoration resulting in a greater roughness of the surface (12). The organic matrix is important too for the susceptibility to coloring (13). The hydrophobic monomers determine colorations at the surface of the restoration (14).

Beside material composition the finishing and polishing procedures can influence the quality of the surfaces of the composite materials being incriminated with early color modifications (15).

Using plastic matrix for exterior surface shaping of the restoration is the best solution for obtaining extremely smooth surfaces that don’t retain extrinsic dyeing substances (9). The results of our study have shown that the samples from the first lot presented slight color modifications by comparison with the samples from the second lot after being introduced for ten days in the dyeing agent. Composite resins like TETRIC and PEKALITE have presented minor or almost no color modification.

Even so, in every day life practice there are frequent clinical situations which require surface burr processing in order to obtain a functional morphology which determine a greater surface roughness that favors frequent color modifications. The type of the abrasive material used, the finishing technique and eventually the use of a finishing paste determines different aspects of the restoration’s surface (16,17). No matter what materials are used for finishing using a surface sealing agent at the end of the procedure ensures a better composite restoration surface (18).

Out of the three dyeing agents used, the red wine has determined the greatest color modifications, the coffee and the red alimentary colorant have determined only minor modifications.

The alimentary colorant has determined the least color modifications in both lots for four composite resins used and didn’t produce any modification in color when using a celluloid matrix for shaping the outer surface. An explanation for the color modification in the case of the other three samples can be attributed to the different degree of water absorbtion by the organic compound (19).

The coffee can determine color modification at the surface of the composite material by adsorbing the dyeing agents onto the surface of the organic phase and by absorbing them in the structure of this phase of the composite resin (20).

The wine used was dark red containing 12% alcohol. Several studies have shown that the alcohol favors restoration surface coloration by weakening the organic matrix of the composite resin (21,22). In our study all the samples introduced in red wine have suffered color modifications, the most important ones being seen at the composite resin samples with a very well represented organic component whose surface has been burr diamond processed.
Conclusions

The composite diacrylic resin based restorative materials on the market have generally good optical properties that are stable in time. Our results have shown that generally there are modifications of the color after long exposures to a dyeing agent but there are important differences that we should take into account in order to obtain a clinical success. The color stability of composite materials is related to the type of diacrylic composite resin, the polishing procedure and the dyeing agent used.

References