

Research Report

Effectiveness of bleaching agent on composite resin discoloration

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ABSTRACT

Background: The discoloration of teeth, especially anterior teeth, is one of aesthetic problems. The use of tooth bleaching agents for discolored natural teeth is becoming increasingly popular. Many dentists, however, get many problems when they conduct bleaching process since there is much composite filling on patient's anterior teeth. Although many research have focused on the discoloration of composite resin after bleaching process, the problem still becomes debatable. **Purpose:** The purpose of this study was to investigate the difference of the discoloration between hybrid composite and nano composite before and after the application of tooth bleaching agent, 38% hydrogen peroxide. **Methods:** Eighteen disk-shaped specimens (5 mm) of each of two composite resins, hybrid and nano filler, were prepared. The each group was treated 3 times and the specimens were divided into two groups consisted of 9 specimens for each, and then immersed in black tea solutions for 72 hours. Next, after having staining and bleaching processes, the color of the specimens was measured with a optic spectrophotometer by using photo with type BPY-47 and digital microvolt. The differences of the light intensity among three measurements were then calculated. Afterwards, GLM MANOVA Repeated Measure and parametric analysis (Independent t-test and Paired t-test) were then used to analyze the data. **Results:** After staining process, it is then known that the nano composite had more discoloration and more affected by the black tea solution than the hybrid one. **Conclusion:** After bleaching, the discoloration was finally removed completely from both hybride and nano filler composite resins and became brighter from the baseline color.

Key words: Discoloration, composite resins, bleaching agent

ABSTRAK

Latar belakang: Salah satu problem estetik adalah adanya perubahan warna pada gigi anterior. Peningkatan pemakaian bahan bleaching semakin populer. Banyak dokter gigi mempunyai problem ketika mereka akan melakukan proses bleaching dan ditemukan banyak tumpatan komposit pada gigi anteriornya. Meskipun telah banyak penelitian yang dilakukan tetapi masalah ini masih menjadi pro dan kontra. **Tujuan:** Melihat perbedaan perubahan warna antara komposit hybrid dan komposit nano sebelum dan sesudah terpapar bahan pemutih gigi hidrogen peroksida 38%. **Metode:** Tiap kelompok mendapatkan perlakuan 3 kali. Dipersiapkan 18 spesimen berbentuk tabung (5 mm) dan dibagi menjadi 2 kelompok masing-masing 9 untuk resin komposit hybrid dan komposit nano. Direndam larutan teh hitam selama 72 jam. Perubahan warna diukur dengan spektrofotometer tipe BPY-47 dan mikrovolt digital, baik sebelum, setelah perendaman larutan teh hitam dan setelah proses bleaching. Perbedaan intensitas cahaya dihitung dengan GLM MANOVA Repeated Measuse dan analisa parametrik. **Hasil:** Setelah perendaman teh hitam, komposit nano mempunyai perubahan warna yang lebih gelap dibandingkan komposit hybrid. Setelah bleaching, baik komposit hybrid dan komposit nano kembali ke warna aslinya. Tetapi perubahan warna komposit nano lebih besar dari pada komposit hybrid. **Kesimpulan:** Setelah bleaching, baik resin komposit hybrid dan nano menjadi lebih terang dari warna aslinya.

Kata kunci: Perubahan warna, resin komposit, bahan bleaching

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INTRODUCTION

The main concern in the dental profession is currently not only the prevention and treatment of disease, but also with the aesthetic factor.¹ The discoloration of teeth, especially front teeth, is one of the aesthetic problem that can be experienced by everyone, especially those whose profession is directly related to public service, such as television broadcasters, artists, teachers, secretaries, etc. Thus, it can lead to psychological disturbances, such as lack of confidence, embarrassment, and low self-esteem. The aesthetic factors are mostly influenced by the nature of smile, the shape of a symmetrical face, the neat row of teeth, and the color of teeth.²

The discoloration of teeth can also occur in composite restoration that comes from intrinsic and extrinsic factors. Intrinsic factor occurs due to the changes of the composite resin matrix itself, the separation of matrix and filler materials, and the oxidation or hydrolysis of the composite resin matrix. Extrinsic factors are caused by the absorption of the dye as a result of the contamination of the various exogenous sources, for instance, the habit of consuming foods and beverages contributes to the formation of stain or stain on the tooth surface, such as black tea, coffee, red wine, and soft drink.³ The colored beverage most widely consumed in the world is actually tea.⁴ Tea mostly sold in markets is black tea, about 98%. And, since tea contains tannin and polyphenol molecules absorbed by the surface of enamel, it can cause the discoloration of the teeth.⁵

Tooth bleaching can also be considered as one of the aesthetic treatments that is often conducted since it is easy to be conducted, far more conservative than the method of restoration, not necessary to have laboratory work, relatively simpler and cheaper to be implemented, and not necessary to have much tissue removed. Therefore, tooth bleaching becomes more popular and attractive to everyone, from young people to adult ones.⁶⁻⁷

Nowadays, many new products of tooth bleaching have recently emerged in markets.⁸ However, if materials of those products contact with tooth structure for long periods of time, it will also bleach tooth materials.⁹ As a results, many dentists have difficulties to whiten teeth if there are so many composite casts in anterior teeth, especially if the composite restorations are still in good shape, either in terms of color and anatomy. Thus, since the discoloration of the composite resin becomes a problem, many studies were then conducted to determine the effect of tooth bleaching on composite resin.¹⁰ Tooth bleaching conducted on vital teeth, for instance, can affect the restoration of composite resin which dark color will change into lighter one.¹¹ The discoloration of composite resin veneer can be eliminated partly through in-office tooth bleaching and repolishing procedures.¹² The use of 10% carbamide peroxide or 10% hydrogen peroxide can lead to the discoloration of composite resin into lighter one.¹³ But, for teeth with the discoloration of composite restoration class IV, tooth bleaching must be conducted with external in office procedures by using 35%

hydrogen peroxide and heat that then will make the teeth and the restoration lighter.¹⁴

Actually, there are many studies focusing on the discoloration problem of composite resin caused by tooth bleaching process, but the problem still become debatable nowadays, in terms of advantages and disadvantages. A research states that if the composite resin is exposed to tooth bleaching agents, it will cause the leakage of the edge of the restoration, reduce the strength and surface roughness of the composite. On the other side, another study states that tooth bleaching causes few or almost no negative effects on all restorative materials. Thus, if composite resin is exposed to tooth bleaching agents, it will only cause less prone to surface roughness, and make compressive strength increased, although it has significant meaning. In other words, although tooth bleaching cause a lot of oxygen released into teeth, the strength of the existing attachment of the restoration will not be reduced or become weak. However, after being exposed to tooth bleaching agents, tooth structure that contains lots of oxygen do not provide a good surface condition for binding new restoration.¹⁵

For these reasons, it is necessary to study the effects of tooth bleaching agent, 38% hydrogen peroxide, on the different discoloration problem of composite resins with hybrid type and nano filler type. Thus, this study is aimed to determine the difference of the discoloration of hybrid composite resin and nano filler composite before and after the application of tooth bleaching agents, 38% hydrogen peroxide.

MATERIALS AND METHODS

Each group was treated 3 times and the sample groups were then distinguished based on the type of composite resin and the application of tooth bleaching agent. Group 1 was composite resin with hybrid type applied with tooth bleaching agent, 38% hydrogen peroxide. Group 2 was composite resin with nano filler type applied with tooth bleaching agent, 38% hydrogen peroxide.

To create the samples, plastic rings with a diameter of 5 mm and with a height of 2 mm were fixated with modeling wax on the glass slab. Two mm composite resin was removed from the tube with plastics filling and then put on the plastic rings. Those rings were closed by celluloid strip, and glass slab was put on the top of them. The excess resin was then cleaned. Both sides of them were light cured with the distance of 0 cm between the surface of the tools and materials, and the tip of light curing unit was perpendicular to the surface of the rings. Light curing was conducted for 20 seconds on both sides with the intensity of 450 mW/cm². Polishing was conducted for 10 minutes. After the first light cured, polishing was conducted with superfine diamond burs for 3 times with one way shear direction of movement followed by polishing with urethane dimethacrylate resin (POGO) for 3 times with one way shear direction of movement without water. Polishing was

then conducted by using low speed micrometer (10,000 rpm) with light pressure. After polishing, all samples were then washed with water as much as 10 ml.

Next, steeping tea was made by dipping a black tea bag in 150 ml of boiling water for 4 minutes, and then the tea bag was removed. Afterwards, the whole parts of the samples of the composite resin were immersed in black tea for 72 hours. The dye was slowly inserted into the resin composites after the immersion for 3 days,¹⁶ because of the inhibition process. Every 24 hours, the solution of black tea was replaced in order not to make fungus *Aspergillus* formed.¹⁷ The composite resin was then washed with distilled water, dried, and stored in artificial saliva.

The composite resin, as a result, had discolored due to the immersion in black tea, and then exposed to tooth bleaching agent, 38% hydrogen peroxide. Prior to the bleaching process, composite resin was polished with pumice and then washed with distilled water. The surface of the composite resin was then bleached and cured as much as 15 rounds (10 minutes). One rotation consisted of both the exposure duration of 30 seconds and the rest duration of 10 seconds. After the tooth bleaching process was completed, the composite resin was washed with running water for 1 minute, dried with suction paper, and stored in artificial saliva.

Before measurement was conducted, the samples were cleaned with water. The measurement was conducted through laser from helium neon gas laser with Uniphase brand which size of the light was reduced by using gap of optical spectrophotometer. The light was dropped on the samples, and then the intensity of light was emitted from the samples. The measurement was conducted by using photo with type BPY-47 and digital microvolt, with the unit of lux (lumen/M²) and the scale of 10². It then could indicate the size of the intensity of the light absorbed by the sample by reducing the intensity light intensity that came from one that was reflected.¹⁸

RESULTS

The results of Kolmogorov-Smirnov test on the hybrid composite resin and the nano filler composite resin showed the value of $p > 0.05$. This indicates that either the hybrid

composite resin groups or the nano filler composite resin groups had a normal distribution of data.

To know the difference of the light intensity of the hybrid composite resin and the nano filler composite resin among all groups including before the treatment, after the immersion in black tea, and after the application of tooth bleaching agent, GLM MANOVA Repeated Measures was conducted. The results showed that p-value was about 0.001. This indicated that there were significant differences of the light intensity of both hybrid composite resin and nano filler composite resin including before the treatment, after the immersion in tea, and after the application of tooth bleaching agent without distinguishing the type of composite resin. Furthermore, to know which treatment groups of the hybrid composite resin have the different light intensity, paired t-test was conducted.

The difference of the light intensity among all treatment groups of the hybrid composite resin was about 0.001 ($p < 0.05$). It indicates that there were significant differences of the light intensity before and after the immersion in tea, after the immersion in tea and after the application of tooth bleaching agent, and before the treatment and after the application of tooth bleaching agent. Moreover, to know the difference of the light intensity in the nano filler composite resin, paired t-test was conducted.

The difference of the light intensity among all treatment groups of the nano filler composite resin was about 0.001 ($p < 0.05$). It indicated that there were significant differences of the light intensity before and after the immersion in tea, after the immersion in tea, after the immersion in tea and after the application of tooth bleaching agent, and before and after the application of tooth bleaching agent. Then, to know both the differences of the light intensity between the hybrid composite resin and the nano filler composite resin before and after the immersion in tea and the differences of the light intensity after the immersion in tea and after the application of tooth bleaching agent, Independent t-test was conducted.

The difference of the light intensity between the hybrid composite resin and the nano filler composite resin before the treatment was about 0.102 ($p > 0.05$). It indicated that there was no significant difference of the intensity of the light between the hybrid composite resin and the nano filler composite resin before the treatment (Table 1). But, there

Table 1. The results of Independent t-test on the light intensity of the hybrid composite resin and that of the nano filler composite resin

Treatment	Composite	p Value of Independent t- test
Before	Hybrid nano filler	$p = 0.102$
The difference before and after the immersion in tea	Hybrid nano filler	$p = 0.006$
The difference after the immersion in tea and after the application of tooth bleaching agent	Hybrid nano filler	$p = 0.004$

was the difference of the light intensity differences before and after the immersion in tea, p -value = 0.006 ($p < 0.05$). This suggests that there were significant differences of the light intensity before and after the immersion in tea. And, it is also known the differences of the light intensity between after the immersion in tea and after the application of tooth bleaching agent, p -value = 0.004 ($p < 0.05$). This suggests that there was a significant difference of the light intensity after the immersion in tea after the application of tooth bleaching agent.

DISCUSSION

In the study, the results showed that both of the hybrid composite resin and the nano filler composite resin had got discoloration. They even had different light intensity after being exposed to tooth bleaching agent, hydrogen peroxide 38%. The change of the light intensity into darker one after the immersion in black tea was because tannin dye in black tea could cause the formation of brown spots on the surface of the composite. Tannin in tea is known to have polar structure that can make the chemical bonds stronger physically, and also make the absorption occur. Moreover, tannin can easily oxidize oxygen out and in water causing the easier change of the color into darker one.¹⁹ The study used optic spectrophotometer so that the infrared light emitted from the laser was absorbed more by the samples that had been immersed in black tea. This indicates that the color of the samples that had been immersed became more reddish or brownish.

In the bleaching process, the samples were bleached by using hydrogen peroxide 38%. The results showed that the light intensity of the hybrid composite resin and the nano filler composite resin had changed into brighter color. This increasing of the light intensity was caused by hydrogen peroxide that can remove any spot attached to the composite resin by breaking H_2O_2 derived from tooth bleaching agents into $H_2O + O_{\mu}$ which not only have the ability to generate free radicals that are highly reactive, but also have unpaired electrons.²⁰ Unpaired electrons or highly reactive O^{\cdot} , therefore, would oxidize tannin from black tea which attached to the composite resin matrix resulting the change of the color of the composite resins into brighter one.

Immersion in black tea can cause the decreasing of the light intensity of both of the hybrid composite resin and the nano filler composite resin. However, the magnitude of the decreasing of the light intensity was significantly different between the hybrid composite resin and the nano filler composite resin. It means that the decreasing of the light intensity of the nano filler composite resin was greater than that of hybrid composite resin. Thus, it can be indicated that the application of hydrogen peroxide 38% can cause the increasing of the light intensity of both of the hybrid composite resin and the nano filler composite

resin. Nevertheless, there was the significant difference of the increasing of the light intensity between the hybrid composite resin and the nano filler composite resin. The light intensity of hybrid composite was smaller than that of nano filler composite resin.

This suggests that if the nano filler composite resin was exposed to tooth bleaching agent, the light intensity of the nano-filler composite resin would be greater than that of hybrid composite resin. It is because the volume fraction in the hybrid composite resin was bigger, about 60%, than that in the nano filler composite resin, only about 57%-59.5%.²¹ As a result, the low volume fraction can cause the increasing size of the gap between the composite resin matrix and the filler material, so it cause more absorption of tooth bleaching.

The amount of the nano filler composite resin absorbing tooth bleaching agent makes the oxidation of tannin derived from a black tea attaching to the composite resin matrix by the O^{\cdot} be more effective. In addition to the hybrid composite resin, the composition of TEGDMA has actually been replaced by using a combination of UDMA and Bisphenol A polyethylene glycol diether dimethacrylate (Bis-EMA). Both of these resins have higher molecular weight, and more double bonds per weight unit, so shrinkage can be reduced and its modulus of elasticity can also be higher than the nano filler composite resin using a combination of Bis-GMA/Bis-EMA/UDMA and small amount of TEGDMA. Free radicals released by tooth bleaching agent then can destroy the composite resin matrix through a process of oxidation and degradation that is by destroying the bonds of monomers contained in the composite matrix. The degradation will occur by breaking the chain of low molecular weight, namely TEGDMA considered as diluent in the organic resin matrix with low viscosity. The hybrid composite has a composition of resin matrix with higher molecular weight and more bonds than the nano filler one. Therefore, if the nano filler composite is exposed to tooth bleaching agent, the process of degradation will be larger. The degradation process then can cause the decreasing of physical and mechanical properties of the composite resins. Later, the condition will lead to the capability of O^{\cdot} in reaching the color pigment of the composite resin to be oxidized into the lighter one. However, this condition more often occurs in the nano filler composite resin than in the hybrid composite resin.²²⁻²⁶

Based on the above discussion, it can be concluded that the application of tooth bleaching agent, hydrogen peroxide 38%, can lighten the color of both hybrid and nano filler composite resin which had darker color after the immersion in black tea. The color of nano filler composite resin even became brighter than that of hybrid composite resin. Thus, it can be said that the application of tooth bleaching agent, hydrogen peroxide 38%, can cause the color of both hybrid composite resin and nano filler composite resin became lighter than the original one.

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