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Original Article
บทวิทยาการ

The use of color modifier and resin cement to mask tetracycline-stained teeth restored with porcelain veneer: a case report

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Abstracts

Objective To present techniques to mask discolored teeth before porcelain veneer cementation using resin-based color modifier as a subopaque layer in severely tetracycline-stained teeth.

Materials and methods A female patient had severely tetracycline-stained teeth on both upper and lower anterior teeth, and space between teeth #11 and #21. Her oral hygiene was good. Based on patient's smile analysis and patient's desires, the treatment plan was agreed upon 16 porcelain veneers on teeth #14 through #24 and #34 through #44. The porcelain veneers were fabricate using IPS Empress E.max®, and used resin-based color modifier as a subopaque layer. The resin luting cement used in this case was Variolink veneer®.

Results The patient was very satisfied with the result. The color of discolored teeth can be masked. The function and occlusion were in proper condition.

Conclusion This case report demonstrated that opaque masking technique was possible to mask severely tetracycline-stained teeth. Nevertheless, the technique cannot eliminate the monochromatic appearance of porcelain veneers on severely tetracycline-stained teeth.

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Key words: *color modifier; porcelain veneer; tetracycline-stained teeth*

Introduction

In 1948, tetracycline broad-spectrum antibiotics were introduced for use in treating gram-positive and gram-negative bacteria in children and adults.[1] All tetracycline compounds consist of four fused cyclic rings (Figure 1). While effective in the treatment of infection, tetracyclines also have systemic side effects-for example, pregnant women are particularly susceptible to tetracycline-induced hepatic damage.[2] Tetracyclines also cross the placenta and have toxic effects on the developing fetus; therefore, they are contraindicated for use during pregnancy.[1] Tetracycline antibiotics are often used in the treatment of acne in adolescents and young adults. Long-term use of tetracycline, particularly minocycline (Minocin) which is a semi-synthetic tetracycline derivative. One of the most obvious and well-documented side effects of tetracycline use is its incorporation as a fluorescent pigment into mineralized tissues, which are being developed at the time of administration. Tetracycline has the ability to chelate calcium ions and incorporate themselves into teeth, cartilage and bone, forming a tetracycline-calcium orthophosphate complex[3] resulting in discoloration and enamel hypoplasia of both the primary and permanent dentitions.[4] Therefore, tetracycline should not be used by children whose teeth are still developing.

The severity of tooth discoloration from tetracycline is considered to be related to dose, frequency and duration of taking tetracycline. During odontogenesis, calcification of deciduous teeth begins at the fourth month of pregnancy and ends at approximately 11-14 months after the baby is born. Permanent teeth begin calcifying after birth, and the calcification is completed at seven to eight years of age, with the exception of the third molars.[5,6] Therefore the administration of tetracycline to pregnant women must be avoided during the second or third trimester of gestation, and to children up to eight years of age because it may result in tooth discoloration and enamel hypoplasia.[7]

In 1984, Jordan and Boksman[8] classified tetracycline-stained teeth into four categories based on severity of the discoloration. Teeth with yellow to gray stains without banding and with uniform color spread throughout the teeth were classified as mild lesions, or first-degree tetracycline-stained teeth. Teeth with yellow-brown to dark gray stains without banding were classified as moderate lesions, or second-degree. Teeth with blue-gray or black stains and significant banding across the surface were classified as severe lesions, third-degree. Finally, teeth with stains so severe that tooth bleaching is ineffective were classified as intractable staining, fourth-degree.

There are several treatment options for tetracycline-stained teeth-for example: tooth whitening, full or partial composite bonding over discolored areas, tooth whitening followed by direct veneers, resin composite or ceramic laminate veneers, and full-coverage crowns. Generally, the degree of tooth whitening from bleaching

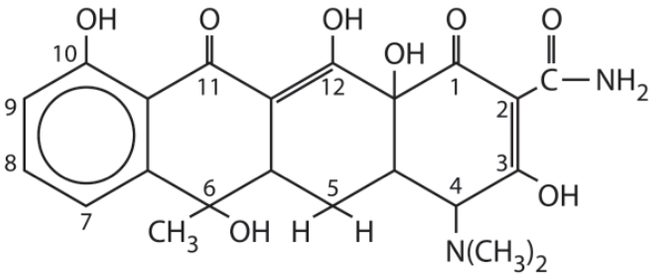

Figure 1 Chemical structure of tetracycline.

of tetracycline-stained teeth is difficult to predict. Whitening alone may not be adequate for the treatment of severe tooth discoloration.[9] The effective alternative treatments include restoring the affected teeth by crowns or veneers with resin composites or ceramic. Direct composite veneers are an alternative to porcelain veneers. Compared to ceramic veneers, direct composite veneers are less expensive and more conservative in terms of preparation. The treatment can be completed in one appointment, while ceramic veneers need more appointments.

Resin composites are generally considered to be less abrasive to opposing teeth than porcelain, and can be repaired when they encounter minor damage. However, there are some material disadvantages, such as color instability and higher wear.[10] Several studies on the color stability of resin-based composites have demonstrated color changes after UV irradiation, and stain forming due to colored food and drinks.[11] After only 1 or 2 years, verifiable and visible changes in color have been observed; therefore, the longevity of composite resin veneers is questionable.

The use of laminate veneers is the most commonly used modality to treat tetracycline-stained teeth. It is generally accepted that the highest levels of retention occur when a veneer is bonded to a predominantly enamel substrate.[12] However, the dark shade of underlying tetracycline-stained tooth structure may show through the porcelain. There are several techniques to deal with this problem, such as using more opaque ceramics and luting agents, including greater tooth reduction to allow for thicker overlaying ceramic. However, the opaque porcelains and luting agents make the restorations appear lifeless, and lack translucency and anatomic characterization. Greater reduction of tooth structure in order to create more space for the ceramic can present problems as well. The difficulty with the latter approach is that dentin provides a weaker bond, and there is a greater risk of failure. In 1996, Nixon[13] suggested the use of subopaque materials, lighter composites, to replace darkest bands of dentin. For tetracycline-stained teeth, highly translucent ceramics are not recommended.[14] Presently, high-strength leucite-reinforced glass-based ceramics, such as IPS Empress I® and Empress Esthetic®, are unsuitable as they allow too much of the underlying discoloration to show through. More opaque systems, such as lithium disilicate glass-based ceramic (IPS e.max® Press; IvoclarVivadent, Liechtenstein) and alumina-based core ceramic (Nobel Procera®; Nobel Biocare, Sweden), are better materials to mask out dark underlying hues.

In this case report, we demonstrated the use of thin layer resin-based color modifier (Kolor + Plus®; Kerr, USA) as an opaquer for masking the dark color of discolored teeth underneath porcelain veneers. Kolor + Plus® is a light-cured, viscous liquid resin color modifier and opaquing kit. It contains eight different color modifiers, one untinted and two different opaquers. As an opaquer, it is instructed to be used by painting on top of the tooth surface after dentin adhesive application, before applying resin composite. For tetracycline-stained teeth, the opaquer is painted to mask the stain. For severely discolored parts, the opaquer is applied in a thicker layer, especially at the band.

The following case presentation demonstrates the restorative protocol using resin-based color modifier as a subopaque layer, together with porcelain veneers on severely tetracycline-stained teeth.

Clinical report

A 36-year-old Thai female presented to the Esthetic Restorative and Implant Clinic at the Faculty of Dentistry, Chulalongkorn University, with the chief complaint of an unpleasant smile due to discolored teeth, and the presence of a space between teeth #11 and #21. Oral examination was performed. Following the classification of tetracycline-stained teeth by Jordan and Boksman,[8] the patient had moderate to severe stains on both upper and lower anterior teeth,

Figure 2 A 36-year-old Thai female patient presented with concerns about tetracycline-stained teeth and space between teeth 11 and 12.

Figure 3 Facial view of the patient's smile showed a low smile line

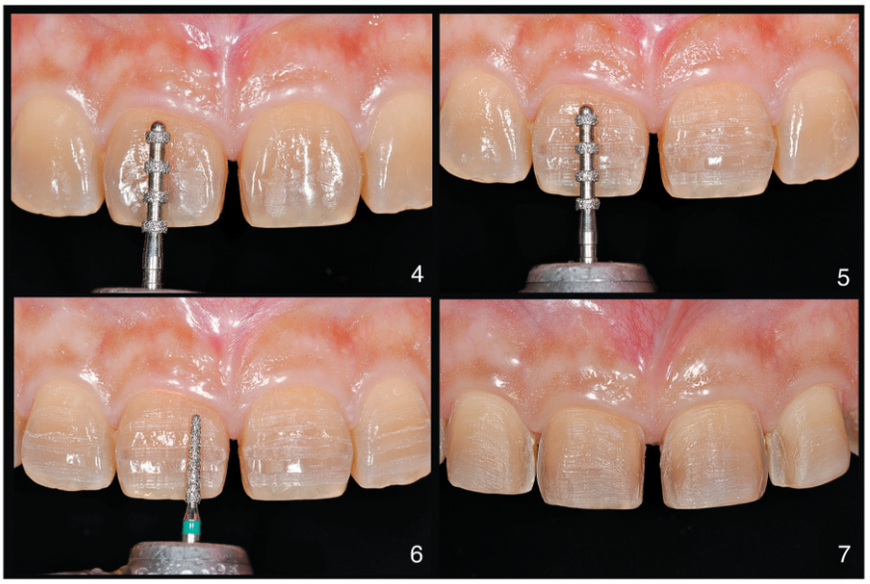

Figure 4 The LVS diamond bur was placed on the labial surface of the tooth.

Figure 5 The tooth surface after depth cut.

Figure 6 The round-ended diamond bur was used in three different planes.

Figure 7 View after the preparation was finished.

and space between teeth #11 and #21 of 1 mm (Figure 2). The dark brown discoloration was pronounced in the middle third and incisal third of all teeth and, to a lesser degree, in the cervical third. The patient had a low smile line (Figure 3) and a Class 1 molar relationship. Her oral hygiene was good, and the gingival tissue was in healthy condition. The patient had rejected whitening prior to treatment. She desired porcelain veneer restoration to address her esthetic concerns. Then, based on these records, patient's desires and patient's smile analysis, the appropriate treatment was planned. In this case report, 16 porcelain veneers were selected for teeth #14 through #24 and #34 through #44. The veneer preparation design utilized incisal bevel in order to create sufficient thickness to achieve proper translucency.

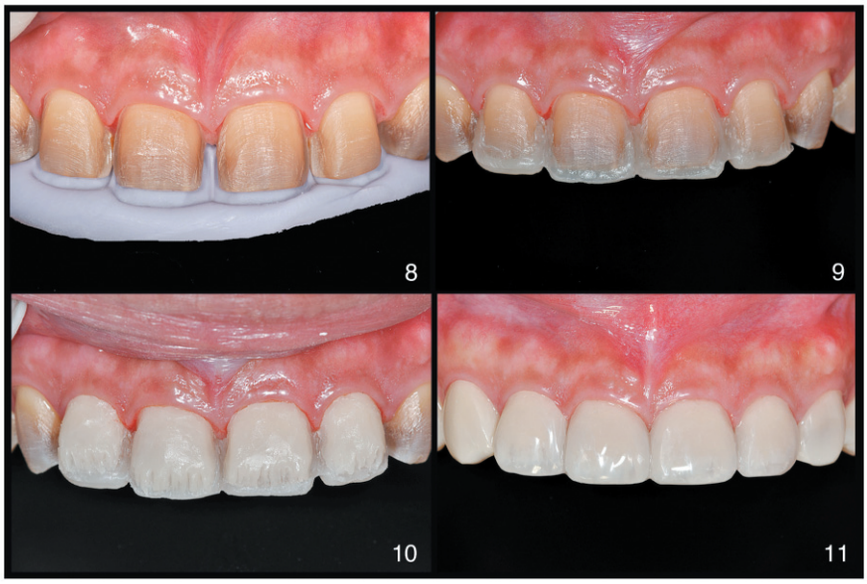

Figure 8 The silicone index was placed on the palatal surface of the prepared teeth.

Figures 9 and 10 The resin composite was placed, and freehand layering technique was used to create the temporary veneers.

Figure 11 After polishing of the temporary veneers.

After the treatment plan was accepted by the patient, teeth were prepared for porcelain laminate veneers. For the maxillary teeth, a depth-cutting diamond-coated bur (Komet®LVS-2; Brasseler, Lemgo, Germany) was used to create cuts of approximately 0.3 mm deep in three planes: the incisal third, middle third and cervical third. Then, round-end cylinder diamonds (D8 and D16 Intensiv®; Swiss Dental Products, Grancia, Switzerland) were used to remove the labial enamel of the prepared tooth to the level of the depth created by the depth-cutting bur. The proximal contacts were cut in half, and the remaining half was maintained in order to preserve tooth width, shape and contour. The mesial surfaces of both central incisors were prepared through the lingual surface (Figures 4-7). The gingival margin was prepared for a chamfer-type margin approximately 0.5 mm below the gingiva. The incisal edges were reduced by 1.0 mm to create sufficient room for layering the veneers to achieve translucency. After preparation, an Ultrapak® retraction cord #3 (Ultradent Products, South Jordan, UT) was gently inserted into the gingival sulcus to displace the gingival tissues away from the marginal area. The margin was refined to ensure the final preparation of a 0.5 mm margin beneath the gingiva. Full-arch impressions were taken with polyvinyl-siloxane material (Flexitime®; HeraeusKulzer, Hanau, Germany). Bite registration with silicone (Blu-Mousse®; Parkell Inc., Edgewood, NY) and a face-bow transfer were also taken. Digital photographs were taken with shade tabs (Vita classic® shade; VITA Zahnfabrik, Bad Säckingen, Germany).

A silicone index made from the diagnostic wax-up model was placed at the palatal surfaces of the upper teeth (Figure 8). Light-cured flowable resin composite (A2 Premise®; Kerr) was placed at the interproximal and incisal area to create the matrix for resin composite temporization. In this case, bonding agent was not needed because the temporary was highly retained to the tooth from the interproximal resin composite. Resin composite was applied by free-hand

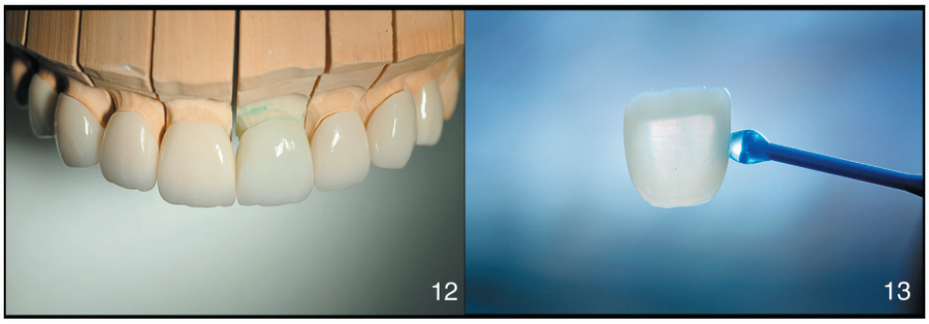

Figure 12 View of the definitive porcelain veneer restoration on the working model.

Figure 13 The porcelain veneer had visible translucence.

carving and shaping to create a natural tooth shape. The patient was instructed to brush every day without using dental floss for one-week period of temporization (Figures 9-11).

A stone model was poured and working dies were fabricated. The model was waxed-up into the final tooth shape and proportionally corrected. Photographs taken before and after preparation were used as a communication tool with the laboratory technician. The patient accepted A1 color tabs (Vita classic® shade; VITA Zahnfabrik, Bad Säckingen, Germany) as the final shade. In order to minimize the effect of the underlying color, a medium opacity (MO) IPS Empress E. max ingot (IvoclarVivadent, Liechtenstein) was used to fabricate the ceramic veneer (Figures 12-13). However, the veneers were so thin (0.5 mm) that they would not be able to mask the moderate to severe tetracycline staining of the tooth; therefore, additional color modifier or opaquer was used as part of the initial plan.

After removing the temporary restorations prior to cementation, the veneers were carefully tried in and checked for proximal contact and marginal fit on the model. Then each veneer was individually checked for fit on the patient's tooth. Finally, they were all tried on the teeth to check for proximal tightness and perfect fit on the prepared teeth. They were gradually adjusted by carefully grinding the proximal surface until they were finally seated on the teeth.

All inner surfaces of porcelain veneers were carefully etched with 9% hydrofluoric acid for 4 min, then washed with water and air-dried. A silane coupling agent (Monobond-S®, IvoclarVivadent, Liechtenstein) was carefully applied to the internal porcelain surfaces with a fine-tipped brush and, after 30 s, gently air-blown with hot air from a hair drier. A thin layer of bonding agent (Heliobond®, Ivoclar Vivadent, Liechtenstein) was applied to internal porcelain surfaces, air-blown, and left uncured.

On the prepared teeth, enamel was cleaned using a flour of pumice slurry, washed with water, and air-dried. A waterproof elastic plumbing tape was then placed on the adjacent teeth. As planned, three veneers were placed on half of the arch and finished before placing the veneers on the opposite half. Teeth numbers 11, 12 and 13 were etched with 37% phosphoric acid for 15 s; then the dentin adhesive (Optibond Solo Plus® ; Kerr) was applied thinly for 15 s using light brushing motion over the surfaces and air thin for 3 s. A thin 2-3 layers of opaquer (A1 opaque, Kolor + Plus®; Kerr) was applied over the bond surface with a fine brush to create a thin layer of opaquer which would help to mask the dark tetracycline staining of the teeth. The opaquer must be kept thin so it would not interfere with the fit of veneer (Figure 14).

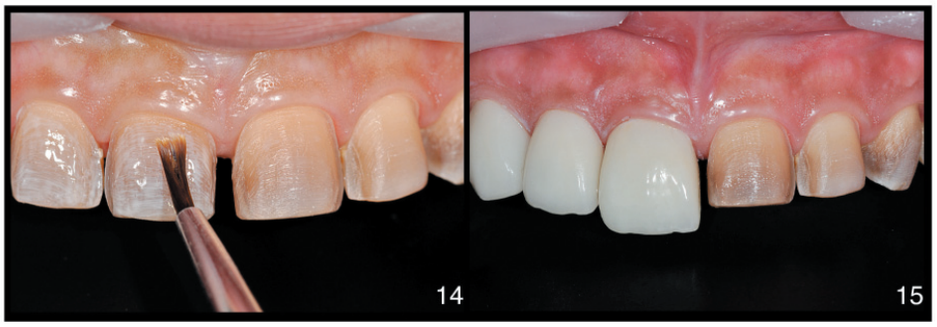

Figure 14 A thin layer of A1 opaque (Kolor + Plus®; Kerr) was applied on the tooth surface after applying the bonding agent.

Figure 15 The porcelain veneers were cemented on teeth #11, #12 and #13.

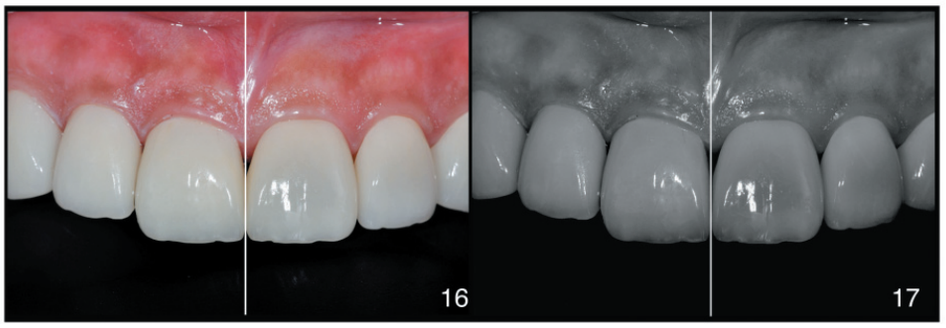

Figure 16 and 17 After cementation with Kolor + Plus® on teeth #11, #12 and #13, compared to the unmasked and uncemented veneers contralateral anterior teeth.

The inner surfaces of three veneers (11, 12,13) were coated with resin luting cement (shade +1, Variolink Veneer®, IvoclarVivadent, Liechtenstein) and were carefully seated into position. After the removal of excess cement interproximally and gingivally, the resin luting cement was pre-cured using a 5 s application of curing light (Optilux®, Kerr) while the veneers were stabilized by finger pressure. The excess polymerized luting cement was removed carefully using a surgical blade no. 12 before finally light-curing with 40 s of light both labially and palatally (Figure 15).

After cementing #11, #12 and #13, the veneers of #21, #22 and #23 were tried on the teeth with water. These demonstrated the appearance of veneers without the use of color opaquer or resin cement. As shown in Figures 16 and 17, the opaquer was able to effectively mask the dark color underneath the porcelain veneers. After fine finishing of the mesial of veneered tooth #11, the veneers (21,22,23) were tried on. Then they were cemented using the same protocol described previously. Finally, veneers of #14 and #24 were placed on the teeth in the same manner. After

Figure 18 The lower anterior teeth after preparation.

Figure 19 Following the bonding agent, Kolor + Plus® was applied on the tooth surface.

Figure 20 The porcelain veneers were fabricated.

Figure 21 After cementation with resin cement.

cementation on both sides, the patient was very satisfied with the results and decided to proceed with treatment on the lower teeth.

In the mandibular teeth, tetracycline staining was severe in the middle third of the teeth. The same principles of preparation design and procedures used for the maxillary teeth were applied to the mandibular teeth (Figures 18-21).

Following cementing of the porcelain veneers, the occlusion was verified and adjusted, and veneers were then polished with a porcelain polishing kit (Figure 23). The final results showed that opaque masking technique had the possibility to mask teeth with moderate to severely of tetracycline-stained.

Discussion

Tetracycline exposure in utero and in early childhood often results in intrinsic tooth staining which varies in severity based on the timing, duration and concentration of tetracycline administered.[15,16] Clinicians need to assess patients' understanding of their dental problems and expectations for treatment outcomes. Patients need to realize that the severity of tooth discoloration, the optical properties of a porcelain veneer system, and the luting agent can influence the final appearance of porcelain veneers. Clinicians must consider the amount of tooth structure available, and do not remove the tooth structure more than the amount of thickness required for fabricating restorations with the desired masking ability.

Figure 22 Pre-operative frontal view.

Figure 23 Post-operative frontal view.

For ceramic veneers, tooth preparation is necessary to avoid over-contouring of the fabricated veneers. Although a large amount of tooth structure can be removed to provide greater thickness for the porcelain veneer, which will provide better masking of the underlying discolored teeth, this procedure is not recommended. Excessive tooth removal can cause dentin exposure, resulting in weak bond of veneer to the dentin. Moreover, with deeper preparation, the darkening of tetracycline-stained teeth will be more obvious, which will make it more difficult to mask the discoloration. Therefore, the preparation should be limited on enamel and as shallow as possible, just enough for producing a veneer of the ideal thickness.

Resin composite was used to restore discolored parts of each tooth in order to mask the dark color of the tooth substructure before veneer cementation. Although this is reported to be a successful technique for masking discolored teeth, the technique also shows some technical difficulties: for example, resin composite sometimes separates from the tooth before veneer cementation. Moreover, the technique does not predictably mask color. It also requires more aggressive tooth removal in order to gain space for added resin composite[16].

Vital bleaching might not be suitable in this case, although vital bleaching is safe and conservative. Furthermore the final result of vital bleaching is varied and unpredictable especially in tetracycline-stained teeth.[17] Full coverage crowns are used as treatment option in severe discoloration cases for decades, however the preparation procedures were considered as aggressive treatment compared the preparation for porcelain veneer. Therefore, veneering is the proper treatment due to conservative preparation and acceptable results.

In this case of tetracycline-stained teeth, highly translucent ceramic veneers (IPS Empress®) were not used because they would have allowed the underlying color of tooth substructure to shine through the thin shell of veneer. A high-opacity ceramic system (E. max® Press, MO, IvoclarVivadent, Liechtenstein) was more suitable for this patient.

Try-in paste can be used, prior to cementation, to estimate the final color of veneers. However, the colors of most try-in pastes are not identical to the color of the luting cement. Thus, the final color of veneers may differ from their true color while trying them. The opacity and translucency of luting cement are other factors which affect the final color. With low-opacity cements, the veneers appear less monochromatic; with high-opacity cements, the veneers appear monochromatic. It is known that high-opacity veneers can mask the underlying tooth color; however this causes the veneers to appear monochromatic. Moreover, for severely darkened teeth, the luting cements will not be able to completely mask the underlying tooth structure beneath the thin ceramic veneers.

Opaquer from resin-based color modifier is recommended to be used for color-masking purposes. It can be used to mask metal color before repairing defects with tooth coloring materials. However, for veneer cementation, resin-based color modifier can only be applied in a thin layer or it will interfere with the seating of veneers. Resin-based color modifier can be added and mixed with resin luting cement, which will increase the opacity and masking ability of the cement. However, this can increase the monochromatic appearance of the veneers. Application of opaquer in a thin layer before veneer cementation was the technique used in this case report. Light activation of color modifier is prohibited because the resin-based color modifier can affect the seating of the veneers.

The operator must use caution while pressing the veneers during cementation. Over-pressure will squeeze the resin-based color modifier away from the bonding surface. The veneer needs to be slowly and gradually pressed during cementation.

A limitation of using this technique is that the clinician has to concentrate on application of the opaquer. If opaque is too thick, it will result in a thick cement line, and this will interfere with the seating of the porcelain veneer. In case of using opaque to mask discoloration, communication with the lab technicians is important. The technicians should follow the instruction to apply at least 2-3 layers of die spacer in order to provide space of the opaquer.

Conclusion

Although conservative all ceramic bonded restorations, such as porcelain veneers, are indicated for esthetic and restorative treatment in the anterior dentition, they can be problematic in teeth, which are highly discolored. However, when severely discolored teeth are treated with the opaquer technique described in this case report, the color of discolored teeth can be masked. Nevertheless the technique cannot eliminate the monochromatic appearance of porcelain veneers on severely tetracycline-stained teeth.

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การปิดสีฟันเททระซัยคลินโดยคัลเลอร์มอดิฟายเออร์ร่วมกับเรซินซีเมนต์ในการบูรณะพอร์ซเลนวีเนียร์

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บทคัดย่อ

วัตถุประสงค์ เพื่อนำเสนอวิธีการในปกปิดสีฟันที่คล้ำผิดปกติก่อนที่จะยึดด้วยพอร์ซเลนวีเนียร์ร่วมกับการใช้คัลเลอร์มอดิฟายเออร์บนฟันที่ติดสีเททระซัยคลินในระดับรุนแรง

วัสดุและวิธีการ ผู้ป่วยมีฟันที่ติดสีเททระซัยคลินในระดับรุนแรงทั้งฟันหน้าบนและหน้าล่างและมีช่องว่างระหว่างฟัน 11 และ 21 ผู้ป่วยมีอนามัยช่องปากที่ดีหลังจากได้วิเคราะห์รอยยิ้มและความต้องการของผู้ป่วยจึงได้วางแผนการรักษาโดยการใช้พอร์ซเลนวีเนียร์ 16 ซี่ ตั้งแต่ฟันซี่ 14 ถึง 24 และ 34 ถึง 44 พอร์ซเลนวีเนียร์ทำมาจากไอพีเอสเอ็มเพลส อีแม็กซ์ และใช้คัลเลอร์มอดิฟายเออร์เป็นชั้นใน ใช้เรซินลูติ้งซีเมนต์ของวาริโอลิงค์ วีเนียร์

ผลการศึกษา ผู้ป่วยมีความพึงพอใจกับผลการรักษาอย่างมาก สามารถปกปิดสีของฟันที่คล้ำผิดปกติได้การใช้งานและการสบฟันอยู่ในสภาพที่เหมาะสม

สรุป รายงานผู้ป่วยนี้ได้นำเสนอถึงวิธีการในการปกปิดสีฟันซึ่งมีความเป็นไปได้ในการปกปิดสีฟันที่คล้ำผิดปกติในฟันที่ติดสีเททระซัยคลินในระดับรุนแรง อย่างไรก็ตามวิธีการนี้ยังคงไม่สามารถที่จะหลีกเลี่ยงที่จะเกิดการมองเห็นสีของพอร์ซเลนวีเนียร์เป็นสีเดียวบนฟันที่ติดสีเททระซัยคลินในระดับรุนแรง

(CU Dent J. 2012;35:119-30)

คำสำคัญ: *คัลเลอร์มอดิฟายเออร์; ฟันเททระซัยคลิน; พอร์ซเลนวีเนียร์*