



Original Article

บทความวิชาการ

Treatment of moderate dental fluorosis using porcelain laminate veneers: A case report

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Abstracts

Objective The purpose of this article was to demonstrate the preliminary report of bonding ability of porcelain laminate veneers to fluorosed teeth after 1 year.

Materials and methods The clinical findings on this patient were dental fluorosis of Thylstrup-Fejerskov Index (TFI) = 5-7. The treatment plan was to place 16 PLVs. Study models showed that the teeth were in good proportion. Wax-up models were used for silicone index. The incisal edge reductions were a feather incisal edge in maxillary teeth and an incisal bevel preparation in mandibular teeth. The laminate veneers were fabricated using the IPS Empress Esthetic system and Variolink II was used as a luting cement.

Results After 1-year follow-up, the porcelain laminate veneers were still in a good condition, with proper occlusion and function. Neither crack nor discoloration could be observed. Moreover, the gingival tissue showed good response with no inflammation. The patient was very satisfied with the results.

Conclusion This case demonstrated the success of using porcelain laminate veneers as an alternative choice in solving esthetic problems that might previously have been treated with full coverage.

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Key words: dental fluorosis; esthetics; porcelain laminate veneer

Introduction

Dental fluorosis, a developmental disturbance of dental enamel, is caused by repeated exposure to high concentrations of fluoride during tooth development, leading to enamel with reduced mineral content and increased porosity. The severity of the fluorosis is individualized. It depends on the timing and duration of the overexposure to fluoride, body weight, degree of physical activity, nutritional factors, and bone growth.¹ The clinical appearance of fluorosis is composed of a spectrum of changes. In its mild form, lusterless white lines or diffuse opacities are present, while in the more severe forms a generalized opaque chalky appearance with confluent pitting and staining of hypomineralized tissues may be seen. Because fluorotic enamel is hypomineralized and porous, after tooth eruption, extensive mechanical breakdown of the surface enamel and secondary staining of the underlying hard tissues usually occur in severely affected dentitions.² Therefore, severe forms of fluorosis not only significantly disrupt enamel but also adversely affect esthetics, causing psychological distress.³

Esthetic changes in permanent dentition are the greatest concern of patients who have dental fluorosis. It usually occurs in children who were excessively exposed to fluoride at 20 to 30 months of age. A critical period for fluoride overexposure is between 1 and 4 years old.⁴ A safe level for daily fluoride intake is 0.5 to 0.7 ppm.⁵ In Thailand, the northern part of the country has the highest incidence of water fluoride content (10–65%) followed by the central part (1.6–18.2%).⁶ The prevalence of severe dental fluorosis was found to be correlated with fluoride in drinking water.⁷

Although there is a considerable amount of literature on the characteristic features of dental fluorosis, little appears to have been written on its management. Clinically, most moderate to severe types of fluorosis are cases requiring definitive dental treatment. Bleaching or microabrasion of severely

fluorosed teeth are often ineffective, or only provide transient results,^{8,9} while composite restorations not only discolor and wear over time, but may also chip or debond.¹⁰ Porcelain laminate veneers (PLV) have been shown to be the restoration of choice for severely fluorosed teeth, as PLV retain their color, wear resistance, and biocompatibility.^{11,12,13} In addition, these veneers require conservative tooth preparation, and hence help preserve much more tooth structure than full crown preparations. This case report documented the result of porcelain veneer as a restoration in patient with dental fluorosis after one year period. It showed preliminary result with successful veneers. We planned to follow up the case through the follow-up periods.

Case report

A 23-year-old Thai female presented with permanent dentition resembling full-mouth fluorosis (Figure 1). Her chief complaint was an unattractive smile due to generalized tooth discoloration. Her medical history was unremarkable. Her brothers, who lived in the same area as the patient (SuphanBuri province), also had discolored teeth. It is possible that they had all consumed the same water supply since their childhood. The level of fluoride in the water around SuphanBuri province is greater than 7 ppm, which can be considered to be a high level compared with a safe level of water fluoridation (0.5–0.7 ppm).^{5,6}

Clinical examination

The clinical examination of the patient revealed generalized enamel fluorosis affecting all permanent teeth (Figure 1). Loss of the outermost enamel in irregular areas involving less than half of the entire surface presented on most surfaces of the maxillary teeth and the premolars and molars of the mandibular teeth. Surfaces of the lower anterior teeth displayed a marked opacity on their surface, with focal loss of the outermost enamel. These teeth were, however, relatively



Figure 1 Generalized enamel fluorosis affecting all of the permanent teeth. (Note a midline deviation to the right side of about 2 mm, and an anterior cross-bite between teeth 22/32).



Figure 2 Occlusal view (above) and Class-III occlusal relationship on both sides (below).

less affected than the upper teeth. The incisal and occlusal surfaces were reduced due to the loss of enamel structure (Figures 2). The patient also had anterior crossbite between 22/32. The upper teeth had a midline deviation of about 2 mm to the right side. The patient had a class-III occlusal relationship, with findings of light contact on anterior teeth and simultaneous bilateral posterior tooth contact in centric

(Figures 2). Eccentric movement demonstrated group function in lateral excursions on both sides, with no interference in balancing side and protrusive guidance. Oral hygiene was good, and the gingival tissue was in healthy condition, except for the lower anterior where slight marginal gingivitis was presented. Radiographic examination showed no caries or alveolar bone loss (Figure 3).



Figure 3 Radiographic examination showed no caries.

Diagnosis

The clinical findings on this patient, as shown in Figure 1, were: dental fluorosis of Thylstrup-Fejerskov Index (TFI) = 5-7, based on the 1978 dental fluorosis classification scheme of Thylstrup and Fejerskov;² and the presence of anterior crossbite between 22/32.

Treatment options

The dental fluorosis classification criteria developed by Thylstrup and Fejerskov is appropriate for determining the modality of treatment, based on biological aspects of dental fluorosis.² Multiple levels of esthetic and conservative treatments need to be considered in esthetically managing teeth with dental fluorosis, based on the severity of the fluorotic condition. Bleaching and enamel microabrasion techniques are conservative, without resulting in excessive wear of sound dental structure. These may be employed in cases of TFI = 1-2 and TFI = 1-4, respectively.¹⁴ Some authors have described the use of both techniques (microabrasion and bleaching) in cases of TFI = 1-4.^{15,16} Both the bleaching technique and microabrasion procedures could be employed only for mild to moderate grade fluorosis and these procedures may need to be repeated several times to obtain satisfactory results.^{17,18} However, the

advantage of these procedures related to their relatively non-invasive compared to other restorative procedures and consume minimum chair clinical time.¹⁹ In the case of extensive loss of tooth surface, as in TFI $\geq$ 5, the use of composite restorations or PLV is indicated, in addition to microabrasion.¹⁴ The advantage of direct composite veneer include minimal clinical steps comparing to indirect ceramic veneers, however the disadvantage were their long term low wear resistance, and less color stability.²⁰ For TFI = 8-9, the use of prosthetic crowns may be required.¹⁴

Treatment plan

Considering the age of the patient and the severity of fluorosis, as well as the presence of anterior lower crossbite between 22/32, the accepted treatment plan to obtain esthetic results and correct the anterior lower crossbite was to place 16 PLVs on the upper teeth from 14 to 24 and on the lower teeth from 34 to 44. The patient was advised to receive generalized scaling. Smile analysis was evaluated to determine the relationship between the smile line and the lower lip line (Figure 4). Her smile line was quite straight. Study models were analyzed to evaluate the occlusal relationship, and



Figure 4 Pre-operative smile and diagnostic wax-up models.



Figure 5a Facial view of the upper anterior teeth.



Figure 5b Facial view of the prepared upper anterior teeth.

diagnostic wax-up models were done (Figure 4). The wax-up models were used for silicone index, diagnosis, assessment of esthetics, and patient satisfaction before proceeding to tooth preparation. The treatment plan was designed according to the recurring esthetic dental (RED) proportion concept. The RED proportion indicates that the proportion of the successive widths of the maxillary teeth as viewed from the front should remain constant, progressing from the width of the maxillary lateral incisor being 70% of the frontal view width of the maxillary central incisor, and the

maxillary canine being 70% of the width of the resulting lateral incisor.²¹ The normal tooth width/length ratios for the lateral incisor and canine are about 0.8 mm, and for the central incisor about 0.88 mm.²² In this case, the RED proportion of both lateral/central incisor and canine/lateral incisor were about 73%. In addition, the coronal tooth width/length ratios of the lateral incisor and canine were about 0.8 mm, and central incisor was about 0.9 mm. Overall, the RED proportion and the width/length ratios in this case were within the normal values. Therefore, pre-treatment of the patient's tooth



Figure 6a Facial view of the lower incisors.



Figure 6b Facial view of the prepared lower incisors.

size and tooth proportions was unnecessary. Modified Ryge criteria were used for evaluation of the veneers (Table 1).²³

Preparation for PLV restoration

Shade selection

Final shade selection was made using a Chromascop Shade Guide (Ivoclar Vivadent, Liechtenstein). The color chosen was DL 3,030.

Tooth preparation

Tooth preparation for PLV required the removal of tooth structure for adequate porcelain thickness. An LVS depth cutter (Brasseler; Savannah, GA) was

used for porcelain laminated veneer preparation, with approximately 0.5–0.8 mm of labial enamel removed, creating a chamfer finish line at the free gingival margin. This line extended one-half of the thickness of the proximal contacts. The proximal contacts were slightly stripped using thin proximal strips (Sof-Lex Polishing Strip; 3M ESPE, USA) for ease of interproximal finishing. For the upper teeth, the incisal edge reduction was a feather incisal edge, which is minimally invasive, retaining the original length and incisal edge of the tooth (Figure 5a, b). For the lower anterior teeth, the incisal edge reduction was an incisal bevel preparation which reduced the incisal edge approximately 1.5 mm (Figure 6a, b). For the lower

Table 1 Modified Ryge Criteria.

Characteristic	Rating			
	Alpha	Bravo	Charlie	Delta
Color match	Matches shade tab in color/shade	Matches shade tab in color/shade	Mismatches shade tab in color/shade by one shade tab gradation or more	Not applicable
Marginal adaptation	No visible evidence of crevice along the margin that the explorer will penetrate	Visible evidence of a crevice along the margin that the explorer will penetrate	Explorer penetrates crevice, reaching dentin, or base is exposed	Restoration is mobile, fractured or missing
Cavosurface marginal discoloration	No discoloration anywhere on the margin between the restoration and the tooth structure	Discoloration present, but has not penetrated along the margin in a pulpal direction	Discoloration has penetrated along the margin in a pulpal direction	Not applicable
Secondary Caries	No caries as evidenced by softness, opacity or etch at the margin of the restoration	Evidence of caries at margin of the restoration	Not applicable	Not applicable
Postoperative sensitivity	No postoperative Sensitivity	Postoperative sensitivity	Not applicable	Not applicable



Figure 7a Facial view of the lower canine and premolar.



Figure 7b Facial view of the prepared lower canine and premolar.

premolar teeth, an occlusal reduction of about 1.5 mm was performed only on the buccal third of the occlusal table, with a chamfer finish line continuous with the facial-proximal outline (Figure 7a, b). All incisal line angles were rounded.

Impression procedure

Following tooth preparation, a gingival retraction cord (Ultrapak Cord #000; Ultradent, USA) was inserted gently into the sulcus, and impressions were taken with additional silicone material (Flexitime; HeraeusKulzer, USA).

Temporization

Temporization was made from direct composite resin. All prepared teeth were spot etched with 37.5% phosphoric acid for 30 s (Gel Etchant; Kerr, USA), and no primer was required. The composite resin (shade A2, Premise; Kerr, USA) was applied to all prepared teeth, then shaped and polished.

Laboratory fabrication

The laminate veneers were produced with the IPS Empress Esthetic system (Ivoclar Vivadent; Liechtenstein) using a combined press/layering technique. The internal surfaces of the veneers were etched with 4% hydrofluoric acid (Porcelain etchant; Bisco, USA) for 4 min, following the manufacturer's instructions, and then treated with silane coupling agent (Monobond-S; Ivoclar Vivadent, Liechtenstein).

Try in PLV restoration

The laminate veneer's fit, form and color were checked on the master cast, both individually and collectively. Teeth were cleaned with a slurry of pumice, and the laminates were again checked on the teeth.

Cementation

The teeth were re-cleaned with a slurry of oil-free pumice, and then etched with 37.5% phosphoric acid for 30 s (Gel Etchant; Kerr, USA). Afterward the teeth were rinsed and blot-dried, and then air-dried without desiccation using oil-free air. Primer (Syntac Primer and Syntac Adhesive; Ivoclar Vivadent, Liechtenstein) was applied and light-cured. A preselected shade (Medium Value 0) of luting cement (Variolink veneer; Ivoclar Vivadent, Liechtenstein) was applied to the internal surface of the PLV, which was carefully placed onto the tooth until fully seated. Using a soft brush or explorer, excess cement was removed from the margins to facilitate the finishing process. While holding the PLV in place, tack-cure of 5 s was used on the labial surface to stabilize the PLV in place and allow for ease of removal of excess cement. This was followed by complete polymerization for 40 s per segment overlapping of the light tip and multiple curing areas. All veneers were cemented and light-cured in the same manner.

Finishing and polishing PLV

Gross finishing was done using ultrafine diamond burs (Brasseler; Savannah, GA) and a 30-fluted carbide bur (Shofu; USA) to remove any remaining excess of luting material on both gingival and incisal margins. For the proximal surfaces, proximal strips (Sof-Lex Polishing Strip; 3M ESPE, USA) were used, and then checked with dental floss. Occlusion was checked in both centric and eccentric excursions, and any needed adjustments were made. The patient was instructed to brush and floss regularly.

Treatment results

The baseline evaluation was completed at two weeks after the restorations were placed (Figure 8).



Figure 8 Facial view of the veneers after two weeks (above) and one year follow-up (below).

One-year evaluations followed (Figures 8, 10). In this study which used Modified Ryge criteria to evaluate the clinical outcome, results were found Alfa-rated and no difference between baseline and after 1-year follow-up. Patients did not report tooth sensitivity or adverse reactions. All restorations showed that the combination of a glazed etched-porcelain to prepared-tooth interface, together with maintenance of good oral hygiene, gave satisfactory esthetic results as well as good gingival response. There was no breakage or discoloration of veneers during the evaluation. Figure 9a, b shows the pre- and post-operative results. The pre- and post-treatment photographs show a significant improvement in esthetics.

Discussion

Enamel fluorosis is characterized by a hypomineralized, acid-resistant superficial layer and porous enamel with areas of subsurface hypomineralization.² According to the classification of the Thylstrup-Fejerskov Index, which is based on clinical changes in fluorosed teeth, this consists of pathological changes in enamel.²⁴ The present case, with TFI 5–7 fluorosed teeth, presented marked opacity or a chalky white appearance on the tooth surface, on which pits may occasionally be presented with diameters less than 2 to 3 mm on the smooth or occlusal surfaces, as well as attrition.²

The durability and clinical success of PLV has been extensively studied. The reported success rate is



Figure 9a Pre-operative smile of the patient.



Figure 9b Post-operative smile of the patient.

more than 95%, and the average durability is more than 5 years.²⁵ Veneers have been shown to provide excellent service over 3 years of function.²⁶ Satisfactory results with PLV restorations were reported at 18 months regarding surface, color, marginal integrity, fracture rate, and gingival tissue response.²⁷ Satisfactory esthetic results were observed in a six-year recall of fluorosed teeth restored with PLV.³ Other studies have shown that moderate fluorosis or fluorosis-like discolored teeth restored with PLV demonstrated satisfactory results.^{28,29} Following the recommended treatment plan, in this case 16 PLV restorations were placed on the upper and lower anterior and premolar teeth.

Current ceramic bonding systems are based on micromechanical bonding between cement and ceramic restorations. The porcelain surface was prepared for increased mechanical retention, including grinding, sandblasting, and acid etching. In addition, the application of a silane coupling agent serves as a chemical surface preparation to enhance the bond strength of porcelain to enamel.³⁰

Moreover, doubling the etching time of moderately fluorosed teeth to achieve typical etching patterns has been reported.³¹ Several studies have compared fluorotic and nonfluorotic teeth treated with 37% phosphoric acid, using scanning electron microscopy. These studies

confirmed that fluorotic teeth had fewer irregularities from the etchant, and also demonstrated that these fluorotic teeth exhibited unpredictability of treatment.^{32,33,34} However, no statistically significant differences in bond strengths of normal and fluorosed enamel were observed when longer etching times were used.³⁵ According to the results of these studies, extended etching times and special treatments were not suitable for the fluorosed teeth in this case.

For severely fluorosed teeth, the hypomineralized surface layer should be ground away before etching the subsurface enamel, and the etching time should be prolonged to at least 90 s.³¹ However, Ateyah and Akpata reported no differences in bond strengths between ground enamel and composite resin for all groups of fluorosis in young patients.³⁶ Furthermore, the bond strength of composites to ground enamel in moderate fluorosis (chalky enamel with pitting) is similar to the bond strength of composites to normal teeth.³⁷ Furthermore, mildly acidic self-etch adhesives do not seem appropriate for bonding to fluorosed enamel, because they yield a less micro-retentive surface.³⁷ An etch-and-rinse dentin bonding agent was reported to have a higher shear bond strength than a self-etch dentin bonding agent in a study of both fluorosed and non-fluorosed enamel surfaces.³⁸ Enamel to resin bonding, produced by etch-and-rinse adhesives, has been observed to be more stable over time.³⁹ Several studies have reported that phosphoric acid application to obtain micromechanical retention on a non-fluorosed enamel surface before the application of dentin bonding agent increased the bond strength of resin to enamel.^{37,40} These results are compatible with the procedures used in this case report.

In addition, clinicians need to understand the masking ability and the transmittance of light shine through of porcelain restorations, including factors such as the thickness and opacity of the materials.^{41,42}

Porcelain veneer can completely mask the underlying discolored tooth substance with minimal reduction of sound tooth substance (0.3–0.7 mm for the labial surface and 0.5–1.0 mm for the incisal edge). However, the veneer's color can be altered by the underlying discoloration.⁴³ The opacity of porcelain can be evaluated by measuring the contrast ratio (CR), which is defined as the ratio of illuminance of the test material. A high CR represents low transmittance of light through the material.^{41,42} Dozic A et al reported that small changes in thickness and shade of opaque and translucent porcelain layers could influence the final shade of the porcelain.⁴⁴ However, the opacity of luting agents may affect the final color of porcelain veneers, so it is helpful to test the restorations with a try-in paste before final cementation.⁴⁵ The luting agents which used to cement porcelain veneers should have a low viscosity for good marginal adaptation of the veneers.⁴⁶

However, many studies reported that the successful results of leucite-reinforced ceramic used in fluorosis cases.^{3,28,29} Beers DH also showed that the satisfactory esthetic results of alumina based ceramic in a severe case.⁴⁷ Furthermore, several researchers have shown that the composites can be bonded reliably and successfully to fluorosed enamel, especially when the enamel exhibits only mild or moderate fluorosis.^{37,40} Many studies have shown that the bond strength of PLV was not significantly different between fluorosed and non-fluorosed enamel surfaces.^{35,38}

Conclusion

PLV have become a popular method for solving esthetic problems in dentistry. The current case demonstrates the use of PLV as a treatment of choice to improve the esthetic appearance of a fluorosis patient, while in the past this case might have been treated with full coverage or direct bonding.

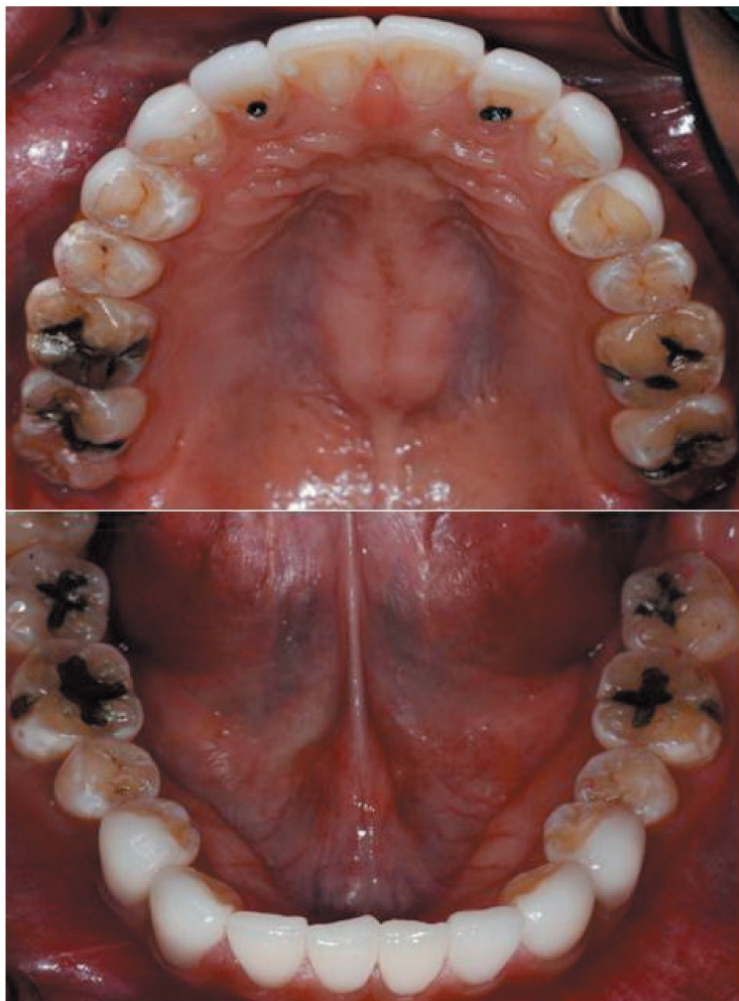


Figure 10 Occlusal view of teeth after 1-year follow-up.

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รายงานการรักษาผู้ป่วยฟันตกกระระดับปานกลางด้วยพอร์ซเลนวีเนียร์

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¹นิสิตบัณฑิตศึกษา หลักสูตรทันตกรรมบูรณะเพื่อความสวยงามและรากเทียม คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

²ประธานหลักสูตรทันตกรรมบูรณะเพื่อความสวยงามและรากเทียม คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

บทคัดย่อ

วัตถุประสงค์ เพื่อรายงานผลการรักษาเบื้องต้นของการยึดติดระหว่างพอร์ซเลนวีเนียร์กับฟันตกกระในระยะเวลา 1 ปี

วัสดุและวิธีการ จากการตรวจทางคลินิกพบว่าผู้ป่วยรายนี้เป็นฟันตกกระในระดับทีเอฟไอ 5-7 จึงทำการวางแผนการรักษาด้วยการบูรณะพอร์ซเลนวีเนียร์เป็นจำนวน 16 ซี่ และจากการวิเคราะห์แบบจำลองศึกษาพบว่าฟันของผู้ป่วยรายนี้มีสัดส่วนที่ดีอยู่แล้วจึงไม่จำเป็นต้องแก้ไขสัดส่วนของฟัน หลังจากนั้นจึงนำแบบจำลองศึกษาซึ่งตกแต่งซี่เสร็จแล้วมาทำแบบแม่พิมพ์ซิลิโคน และทำการหล่อแต่งทางด้านปลายฟันเป็นแบบขอบเขตสิ้นสุดพอดีที่ปลายตัดในฟันบนและเป็นแบบขอบเขตสิ้นสุดเกิดจากการกรอตัดปลายทั้งในฟันล่าง พอร์ซเลนวีเนียร์ถูกทำมาจากเซรามิกไฮไฟเอสเอ็มเพรสเอสเรติกและยึดติดด้วยซีเมนต์วาริโอลิงค์ทู

ผลการศึกษา จากการติดตามผลการรักษาเป็นระยะเวลา 1 ปี พบว่าพอร์ซเลนวีเนียร์ยังอยู่ในสภาพดี สามารถใช้บดเคี้ยวได้ดี ไม่มีรอยแตกร้าวและไม่พบการเปลี่ยนสี นอกจากนั้นเนื้อเยื่อเหงือกยังมีการตอบสนองที่ดีต่อพอร์ซเลนวีเนียร์ ไม่พบการอักเสบเกิดขึ้น และผู้ป่วยพึงพอใจมากกับผลการรักษา

สรุป พอร์ซเลนวีเนียร์เป็นอีกวิธีหนึ่งที่สามารถใช้ในการแก้ไขปัญหาเรื่องความสวยงามในผู้ป่วยฟันตกกระได้ ซึ่งแต่ก่อนอาจจะต้องได้รับการรักษาด้วยการครอบฟัน

(ว.ทันต.จุฬาฯ 2555;35:49-64)

คำสำคัญ: ความสวยงาม; พอร์ซเลนวีเนียร์; ฟันตกกระ