THE LONGEVITY OF CERAMIC VENEERS: CLINICAL EVALUATION OF MECHANICAL, BIOLOGICAL, AND ESTHETIC PERFORMANCES OF CERAMIC VENEERS UP TO 7-YEARS RETROSPECTIVE STUDY

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Esthetic Restorative and Implant Dentistry
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ผลการศึกษาในทางคลินิกย้อนหลัง 7 ปี ต่อความยั่งยืนของเซรามิกวีเนียร์ทั้งทางเชิงกล ชีวภาพ และความสวยงาม

นางสาวรพีพรรณ มนต์อารักษ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Thesis Title	THE LONGEVITY OF CERAMIC VENEERS: CLINICAL EVALUATION OF MECHANICAL, BIOLOGICAL, AND ESTHETIC PERFORMANCES OF CERAMIC VENEERS UP TO 7-YEARS RETROSPECTIVE STUDY
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Field of Study	Esthetic Restorative and Implant Dentistry
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รพีพรรณ มนต์อารักษ์ : ผลการศึกษาในทางคลินิกย้อนหลัง 7 ปี ต่อความยั่งยืนของเซรามิกวีเนียร์ทั้งทางเชิงกล ชีวภาพ และความสวยงาม (THE LONGEVITY OF CERAMIC VENEERS: CLINICAL EVALUATION OF MECHANICAL, BIOLOGICAL, AND ESTHETIC PERFORMANCES OF CERAMIC VENEERS UP TO 7-YEARS RETROSPECTIVE STUDY) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ทพ.เฉลิมพล ลี้ไวโรจน์, 175 หน้า.

วัตถุประสงค์: เพื่อประเมินผลทางคลินิกย้อนหลังต่อความยั่งยืน และความสำเร็จของเซรามิกวีเนียร์ในผู้ป่วยที่ได้รับการรักษาด้วยเซรามิกวีเนียร์ที่คลินิกทันตกรรมเพื่อความสวยงามและรากเทียมจุฬาลงกรณ์มหาวิทยาลัย มาอย่างน้อย 5-7 ปี ทั้งทางด้านทางกล ทางชีวภาพ และความสวยงาม

วิธีการทดลอง: ผู้ป่วยที่ได้รับการรักษาด้วยเซรามิกวีเนียร์ที่คลินิกทันตกรรมเพื่อความสวยงามและรากเทียมจุฬาลงกรณ์มหาวิทยาลัยมาอย่างน้อย5-7ปี ผู้ป่วยทุกรายได้รับ การตรวจประเมินผลด้วยแบบสอบถามความพึงพอใจ และการตรวจประเมินผลทางคลินิก ทั้งด้านทางกลทาง ชีวภาพ และ ความสวยงาม โดยทันตแพทย์ 2 คน ในช่วงเดือนกันยายน พ.ศ. 2559 ถึง สิงหาคม พ.ศ. 2560 เกณฑ์การตรวจปรับปรุงมาจากเกณฑ์การประเมินของ USPHS และ FDI criteria อัตราความ สำเร็จของวีเนียร์เริ่มวัดตั้งแต่ยึดซีเมนต์สำเร็จและล้มเหลวเมื่อเซรามิกวีเนียร์ไม่สามารถซ่อมแซมได้ Kaplan-Meire analysis ถูกใช้เพื่อประเมินผลความสำเร็จของเซรามิกวีเนียร์ ที่ระดับนัยสำคัญ 0.05

ผลการทดลอง: ผู้ป่วยที่สามารถเข้ารับการตรวจประเมินที่คลินิกทันตกรรมเพื่อความสวยงามและรากเทียม จุฬาลงกรณ์มหาวิทยาลัยมีทั้งหมด 26 ราย มีวีเนียร์ทั้งหมด 163 ซี่ ผลการประเมินด้านความสวยงาม ร้อยละ 99.4% (n=162) ของเซรามิกวีเนียร์มีสีเหมือนกับฟันข้างเคียง ผลการประเมินด้านเชิงกล พบการแตกหักของวีเนียร์ที่ต้องรื้อแก้ไข ร้อยละ 1.8 (n=3) และสามารถ ซ่อมแซมได้ร้อยละ 1.2 (n= 2) พบการหลุดของเซรามิกวีเนียร์ร้อยละ 0.6 (n=1) มีการเขี่ยติดตามขอบของวีเนียร์กับฟันเล็กน้อยมีร้อยละ 4.9 (n=8) พบการติดสีตามขอบของเซรามิกวีเนียร์ที่สามารถขัดออกได้ ร้อยละ 0.6 (n=1) ผลการประเมินเชิงชีวภาพ พบเหงือกอักเสบระดับเล็กน้อย ร้อยละ 3.1(n= 5) อักเสบระดับ ปานกลางร้อยละ 9.8 (n= 16) มีผู้ป่วยร้อยละ 12.3 (n= 20) เคยมีประวัติเสียวฟันภายหลังได้รับการรักษาด้วยเซรามิกวีเนียร์ ไม่มีผู้ป่วยรายใดมีฟันผุบริเวณที่ได้รับการรักษาด้วยเซรามิกวีเนียร์ ผลการประเมินจากภาพรังสี พบมี ผู้ป่วย 1 รายที่มีพยาธิสภาพรอยโรคปลายรากภายหลังได้รับการรักษาด้วยเซรามิกวีเนียร์ ส่วนใหญ่ผู้ป่วยมีความพึงพอใจ ต่อความสวยงาม การใช้งาน และการดูแลทำความสะอาดฟันที่ได้รับการรักษาด้วยเซรามิกวีเนียร์ในระดับมาก อัตราความสำเร็จของ เซรามิกวีเนียร์ร้อยละ 97.5%

สรุป: ฟันที่ได้รับการบูรณะด้วยเซรามิกวีเนียร์ที่คลินิกทันตกรรมเพื่อความสวยงามและรากเทียมมีอัตราความสำเร็จสูง สาเหตุที่ล้มเหลวส่วนใหญ่มากจาก การแตกหัก และการหลุดของเซรามิกวีเนียร์ตามลำดับ

สาขาวิชา ทันตกรรมบูรณะเพื่อความสวยงามและทันตกรรมรากเทียม ลายมือชื่อนิสิต .....

ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2560

5875829532 : MAJOR ESTHETIC RESTORATIVE AND IMPLANT DENTISTRY
KEYWORDS: CERAMIC VENEER / CLINICAL EVALUATION / LONGEVITY / PORCELAIN LAMINATES VENEER / SUCCESS RATE

RAPEEPAN MONARAKS: THE LONGEVITY OF CERAMIC VENEERS: CLINICAL EVALUATION OF MECHANICAL, BIOLOGICAL, AND ESTHETIC PERFORMANCES OF CERAMIC VENEERS UP TO 7-YEARS RETROSPECTIVE STUDY. ADVISOR: ASSOC. PROF. CHALERMPOL LEEVAILOJ, 175 pp.

Purpose: To evaluate the longevity and mechanical, biological and aesthetic performance of ceramic veneers placed after 5 to 7 years in service.

Materials and Methods: Ceramic veneer restorations were clinically examined following modified from the United States Public Health Service (USPHS) and World Dental Federation (FDI) criteria. Clinical evaluation was performed by two clinicians regarding mechanical, biological and aesthetic performances during maintenance appointments between September 2016 and August 2017. Intra-examiner and inter-examiner reliability were evaluated by calculating the intraclass correlation coefficient and inter-examiner calibration. The results were analysed by Kaplan-Meier survival estimation method and log-rank test at a 95% confidence level.

Results: One hundred and sixty-three veneers were placed in 26 patients with mean clinical service of 68.1 ± 0.66 months. Overall survival rate of the veneer restoration was 97.5% with 2.5% (4 veneers) presenting clinically unacceptable problems such as fracture and debonding. The aesthetic parameter was rated as excellent by 99.4% (n = 162). Caries was not detected in any teeth. Radiographic examination determined the development of a periapical lesion in one patient after veneer placement. Most patients were comfortable with the restoration and satisfied with the aesthetic results.

Conclusion: Ceramic veneers demonstrated a high survival rate with most failure cases resulting from fracture and debonding.

Field of Study: Esthetic Restorative and Implant Dentistry Student's Signature .....
Advisor's Signature .....

Academic Year: 2017

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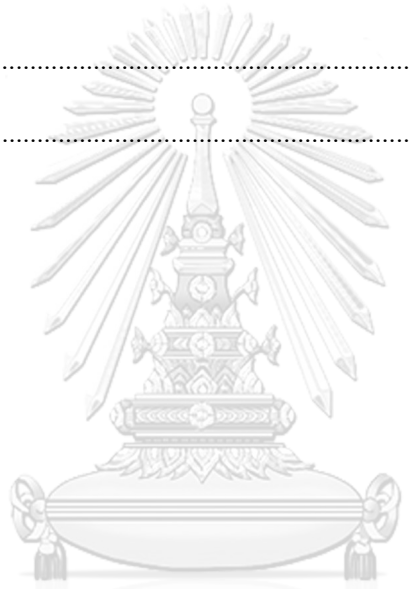

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CHAPTER 1

INTRODUCTIONS

I Background and rationale

Introduction

At present, people are more concerned about facial and dental aesthetics as an expression of their individual personality and a way to boost self-confidence.[1-4] Dissatisfaction with tooth color and shape has increased the demand for cosmetic dental treatment. Available options to restore unaesthetic teeth and create sparkling smiles consist of both direct and indirect veneer treatment.

Direct resin composite veneers are applied straight onto prepared tooth surfaces at a dental clinic. Minimal tooth preparation renders this conservative technique an excellent as well as economical and aesthetic treatment.[5] Disadvantages include marginal leakage, low color stability, low wear resistance and susceptibility to discoloration, which affect long-term aesthetic results.[6-11]

The application of indirect ceramic veneers involves minimally invasive preparation with high aesthetic appeal, proven biocompatibility and predictability in addition to good mechanical properties.[2, 11-14] Ceramic veneers have become the first choice of patients for alteration of color, shape restoration, multiple teeth spacing and alignment of malposition teeth. Ceramic veneers have also been proven to be highly effective for stabilising the color of tetracycline-stained teeth.[15]

Longevity is one of the most important factors to predict the survival and success of restorations. Many longitudinal clinical studies have evaluated the performance of ceramic veneer restorations and confirmed good clinical performance, excellent aesthetics and also a high level of patient satisfaction. Major clinical complications commonly resulting in failure of ceramic veneer restorations are fracture and debonding. [2, 7, 8, 13, 16-19]

However, there is no studied review the longevity of ceramic veneers in aspects of mechanical, biologic and esthetic evaluation for 5-7 years ceramic veneers were placed at department of Esthetic restorative and Implant dentistry program, Chulalongkorn University.

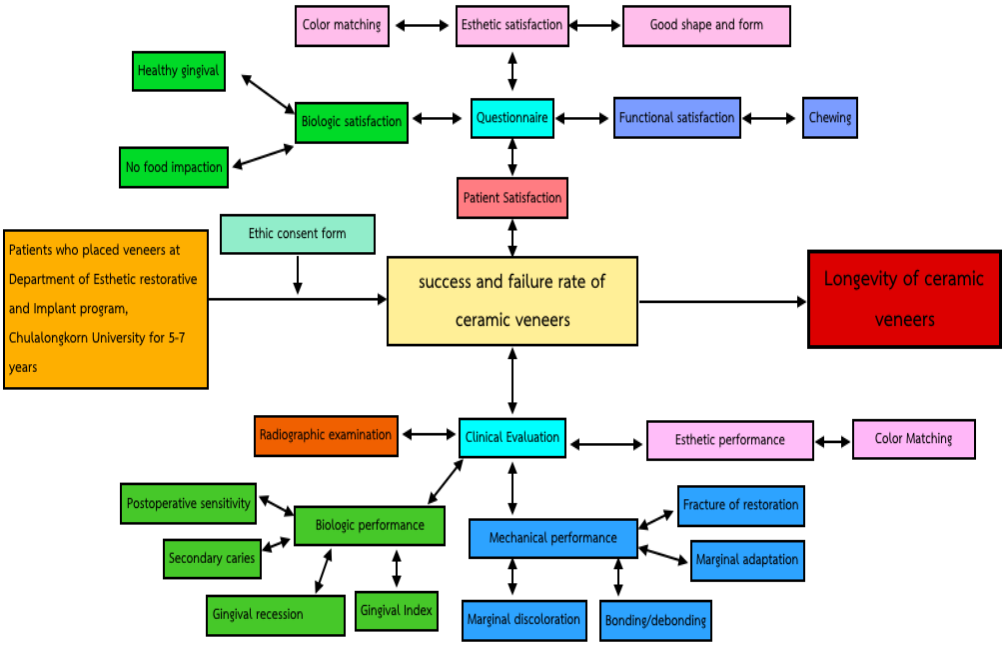
The research question

What was the longevity and success rate of ceramic veneers after placement up to 7 years at department of Esthetic restorative and Implant dentistry program, Chulalongkorn University?

Objective of the Study

This retrospective study reviewed clinical performance and patient perception regarding the mechanical, biological and aesthetic qualities of ceramic veneers placed between 5 to 7 years ago at the Department of Esthetic Restorative and Implant Dentistry, Chulalongkorn University.

Conceptual Framework



Study Limitation

The study population included 26 subjects and was limited to patients treated in the Department of Esthetic Restorative and Implant Dentistry Program over the past 5-7 years. Prospective subjects received a phone call advising them to contact the esthetic clinic. Some could not be reached since they were now living in other countries, while others had changed their mobile phone numbers.

Keywords

Longevity of restoration/ceramic veneer, durability of ceramic veneer, laminate veneer/porcelain veneer, Clinical evaluation of ceramic veneer.

The Expected Benefit

The results from this study assisted the clinician to concern risk factor of failure of ceramic veneer restoration. Also, this study applied guideline to evaluate and maintenance of ceramic veneer from this clinical evaluation form.

CHAPTER II

REVIEW OF THE LITERATURES

The literature in the following topics will be reviewed.

- ✓ Indication and contraindication of porcelain veneers
- ✓ Veneer preparation
- ✓ Luting procedure
- ✓ Survival and failure rate of porcelain veneers
- ✓ Clinical criteria for evaluation of restoration

Indication and contraindication of porcelain veneer

Indication of porcelain veneer.[2, 14, 20]

1. Tooth discoloration
    a. Patient who suffer with tooth discoloration such as Tetracyclin, Fluorosis, Amelogenesis Imperfecta
2. Morphological modification

a. Misshape teeth such as peg shape or conical shape. Most common of misshape teeth is Upper lateral incisor. Porcelain laminate veneer can offer more predictable and esthetical result than using composite veneer.

b. Diastema and multiple space teeth, especially anterior teeth. Veneers are an alternative choice for closing multiple spaces instead of orthodontic treatment.

c. Slightly Misalignments of teeth such as slightly proclination, retroclination, mesioversion, and/ or lateroversion of tooth.

3. Improved pleasing smile: porcelain laminate veneers can realign anterior teeth into good position, normal teeth proportion and brighter color of teeth.

Contraindication of porcelain laminate veneers.[20]

1. Enamel has an extensive reduction and/or poor quality of enamel. For example in case of extended caries and large restoration; often require a full crown

because the enamel surface is not enough to support and to create retention of veneers.

2. Patients with parafunction habit, such as nail biting, clenching and bruxism etc. should be avoid. In the study of Magne et al., 1999 reported that patients with parafunction activities showed low success rate, which was reduced to 60%.[21]

3. Patients with bad oral hygiene should be avoided. The carious lesion may recurrent and increase failure of restoration.

4. Patient with high expectation should be avoided.

Veneer preparation

One of the most success factors of porcelain veneers is the appropriate tooth reduction. The concept preparation is conservative, which remains in enamel have proven to be beneficial for increasing the longevity of restoration and tooth. Tooth preparation of porcelain veneers is necessary, because it creates space for porcelain and thickness of resin cement without over-contouring the tooth.[22, 23] Also, tooth preparation can generate path of insertion, which prevents crack or fracture of ceramic

veneers. Moreover, The Incisal reduction about 1- 1.5 mm., which was substituted with translucency of ceramic restoration, can create a maximum esthetic appearance. Incisal edge reduction.[23]

As is the case for all types of preparations based on mock up the final shape and volume of the restoration from with acrylic resin before preparation. This technique will preserve enamel and ascertain the length and shape of the future restoration. Also, it can confirm that there are no interferences with function, phonetics and overall comfort of the patient.[24, 25] Moreover, the aesthetic pre-evaluative temporary (APT) technique applied by Galip Gurel is a provisional on the tooth structure before the teeth have been prepared. This will give a dentist and technician the exact volume of tooth reduction. This technique is a minimally invasive technique, hence making the treatment predictable.[26, 27]Friedman MJ et al., 2001 concluded that the longevity of a bonded porcelain veneer related with amount of enamel substrate supporting it. The best long-term retention for porcelain veneer restorations is

achieved when 50% of the supporting substrate is enamel and all finish lines end within enamel.[11]

There were four preparation designs have been described to the incisal edge

- Window or Intraenamel preparation. Incisal finishing line is taken close about 0.3-0.5 mm. from the incisal edge. Although this preparation can retain the natural enamel over the incisal edge, it may produce a poor margin of weakening the enamel at the incisal edge. In addition, it is difficult to hide the margins of the veneers. Shetty A et al., 2011 showed a survival rate of 89% in this design with 11% failure rate from interfacial staining, debonding, and minor failures.[22]
- Feather incisal edge. The veneer is taken up to the height of the incisal edge, but the edge is not reduced. This has the advantage of maintaining anterior guidance, but the veneer is liable to be fragile at the incisal edge and may be subject to peel/shear forces during protrusion. Shetty A et al., 2011 showed a survival rate of 75%.[22] Christensen GJ et al., 1991 evaluated this design for 3 years and concluded that it had a great marginal fit.[28]

- Incisal Bevel preparation, in which a bucco-palatal bevel is prepared across the full width of the preparation. There is some reduction of the incisal length for better aesthetic control at this area and facilitates the seat of the veneer during try-in and cementation.

- Incisal Overlap preparation or palatal chamfer. The incisal edge is reduced and extended onto palatal aspect of preparation. This provides a positive seat of the veneer during luting. However, it involves a more extensive tooth preparation. It modified the path of insertion, so the veneer has to be seated from the bucco- incisal direction rather than from the buccal alone.

Jankar AS et al., 2014 compared fracture resistance of ceramic veneer between three types of incisal preparation. They concluded that palatal chamfer preparation had a highest fracture resistance as compared to 1mm. incisal reduction and no incisal reduction.[29]According with study of Li Z et al., 2014 evaluate a three-dimensional finite element study on anterior laminate veneers with different incisal preparations and concluded that the palatal chamfer design for porcelain laminate veneers

tolerated stress better than butt-joint design.[30]

Shetty A et al., 2011 found that the most conservative type was window preparation. Moreover, incisal coverage was better than no incisal coverage. It showed a high survival rate because of better stress distribution. Incisal overlap was preferred for healthy normal tooth with sufficient thickness and incisal butt preparation was preferred for worn tooth and fractured teeth.[22] According with Fernando Zarone F et al., 2005 studied the Influence of tooth preparation design on the stress distribution in maxillary central incisors. They concluded that the chamfer with palatal overlap preparation had a better natural stress distribution under load than the window technique.[31]

Interproximal extension[23]

In the case of minimum preparations, the contact point with adjacent teeth should be maintained. However, if major changes in form or the closure of Diastema are planned, a preparation through the contact area is recommended. This allows dental ceramist to build a veneer that matches to the anatomy form and the

emergence profile of the tooth.

Finish line [23]

The creation of a chamfer with round internal line angles is recommended. The finish line should be at the crest of the free gingival margin. However, it may extend the preparation into gingival embrasure for masking discolored tooth.

Burke FJ et al., 2012 reviewed a Survival Rates for Porcelain Laminate Veneers with Special Reference to the Effect of Preparation in Dentin and concluded that; there is reasonable evidence indicating that a veneer preparation into dentin adversely affects survival. They suggested that success of the porcelain veneer technique involves the planning the case Conservative (enamel-saving) preparation of teeth, proper selection of ceramics, proper selection of the materials and methods of cementation, proper finishing and polishing of the restorations and proper planning for the continued maintenance of the restorations.[32]

Luting procedure

Bonding procedure is one of the most important factors for porcelain veneer

technique in order to change the color, form and/or position of anterior teeth. The success of the porcelain veneer restoration is influenced from these three components; the veneer, luting agent and tooth, which form the adhesion complex.[2]

1. Ceramic surface[2]

The method of ceramic surface treatment is an important factor, which has influence to bond strength between porcelain and tooth structure. Sandblasting, etching technique and silane coupling agents are the most common procedures that can improve the result. The study of Guarda GB et al., 2013 investigated the effect of two surface treatments on microtensile bond strength of IPS e.max® and concluded that etching with 10% hydrofluoric acid for 20 seconds significantly increased microtensile bond strength when compared to sandblast with 50-μm aluminum oxide particles for 5 seconds.[33]

Additional, etching with hydrofluoric acid at the inner side of the porcelain veneer creates a retentive etch pattern. From Peumans M et al., 2000 showed SEM after etched porcelain surface reveals an amorphous micro-structure with numerous

porosities. These micro-porosities create a micro-mechanical interlocking of the resin composite by increasing the surface area for bonding.[2] There are lots factors effect to the micro-mechanical interlocking of the resin composite, which include the etching time, the concentration of the etching liquid, the method of fabrication of the porcelain restoration and the type of porcelain. Ultrasonic cleaning with 95% alcohol, acetone or distilled water is necessary to remove all residual acid and dissolved debris from the porcelain surface.

Silanization with a bi-functional coupling agent, which response for creating covalent bond (Si-O-Si) between the inorganic ceramic phase and the organic phase of the resin cement, applied on etched porcelain surface provides a chemical link between the luting cement and porcelain. Also, heating of the silane-coated porcelain could increase a bond strength twice compared with no heating.[34] Moreover, several studied confirmed that etching the inner side of porcelain veneer and silanizing can increase bond strength of luting cement to enamel surface.[2, 35, 36]

2. Tooth surface[2]

The type of bonding surface and the type of surface conditioning affects the bond strength of the ceramic to the tooth structure.[37] The longevity of porcelain veneers will be affected if dentin bonding is not achieved correctly.

When the preparation maintained into the enamel, enamel reduction is required to improve the bond strength of the resin composite to the tooth structure. Thus, the aprismatic top surface of enamel is removed. When the enamel is cut, an organic smear layer is formed on the remaining surface. Etching with a 30-40 % phosphoric acid dissolves the inorganic components of smear layer and changes the smooth surface of the enamel to an irregular one in order to achieve a micro-mechanical interlock with the composite resin. The enamel prisms form a rough surface that makes it more receptive to adhesion. After polymerization, resin tags are formed in the micro porosities of the etched enamel, creating a resistant and lasting bond.

If a considerable area of dentine has been exposed during tooth preparation, dentine adhesion must take place. During cutting, a smear layer is formed, consisting

of burnished components and hydroxyapatite fragments. The smear layer blocks the dentine tubules, stops the tubule fluid from escaping and prevents the formation of chemical and/or micromechanical retention of the dentine bonding agent. Thus, pre-treating the dentine surface becomes essential to obtaining effective adhesion. Traditional dentine protocols include:

- Etching with a 30-40 % phosphoric acid for 15 seconds. Etching dissolves the smear layer and demineralizes the dentine, resulting in a wide opening of the dentine tubules. Then, rinse with water until etchant has been completely removed about 15 seconds. Gently air dry for a few seconds being careful not to desiccate dentin

- Primer was applied to penetrate the collagen fibers and promotes the flow of bonding agent. Place applicator tip for applying Primer to the prepared enamel/dentin surfaces with a light scrubbing motion for 15 seconds. Gently air dry for approximately 5 seconds. At this point the dentin/enamel surface should have a slightly shiny appearance.

- Application of a bonding bonding agent penetrates the collagen net and forms a mixed zone of demineralized dentine and unfilled composite. This zone represents a key factor for the success of dentine bonding. Using the applicator brush for applying bonding to the prepared enamel/dentin surfaces with a light scrubbing motion for 15 seconds. Blow to margin or to thin if necessary using a light application of air.

3. Luting cement

Adequate polymerization is very important to resin bonded ceramic restorations. There are lots effects of incomplete polymerization of resin cement. For example, it can lead to color instability, toxicity from residual monomer, decreased bond strength, and post-operative sensitivity, increasing the risk of microleakage and caries.

The light-curing resin cement has been proposed as luting agents of porcelain veneers. They allow a longer working time, which allow dentist to remove excess cement before curing, when compared with dual cure or chemically curing materials.

Also, it showed superior color stability than dual-cured composites.[2] Cho SH et al., 2015 reported that the microhardness values of light-cured resin cement groups showed higher values than dual-cured luting cement. Also, thicknesses of ceramic veneers have effect to the microhardness in dual cure luting cement.[38] On the other hands, light-cured resin cement groups showed no difference effect to the microhardness among thickness. According to Runnacles P et al., 2014 suggested that the composition and the thickness of the ceramic have effect to the light.[39] The thickness of the porcelain veneer is very important to the light transmittance available for polymerization. The porcelain veneer absorbs between 40–50 % of the emitted light, which determined the light transmittance available for polymerisation. The color and the opacity of the porcelain would have less influence on the amount of absorbed light. The light-cured cement should be used carefully when ceramic veneers thicker than 1.5 mm. are employed because the light reaching the underlying cement may be less than required. [2, 40, 41]

Success and failure rate porcelain veneers

The longevity of restorations is one of the most important factors to predict

the survival and success of restoration. There are many longitudinal clinical studies have been evaluated the performance of porcelain laminate veneers.

Calamia JR et al., 2007 reviewed reason for 25 years success of Porcelain Laminate Veneers. These past 25 years of success can be attributed following in the areas: planning the case, conservative (enamel saving) preparation of teeth, proper selection of ceramics to use, proper selection of the materials and methods of cementation of these restorations, proper finishing and polishing of the restorations, and proper planning for the continuing maintenance of these restorations.[18]

Shade selection success is understanding that the final color obtained is a combined metamerism of the tooth, the resin cement selected, and the porcelain used for the restoration.

Marginal discoloration and loss of color stability is a seldom problem. If a well-fitted restoration which, a thin viscosity, but highly filled, resin cement has been used with proper finishing and polishing techniques, immediate marginal discoloration is rare, and little or no marginal discoloration is usually seen at long-term follow-up. In

contrast, ill- fitting veneers, which expose inappropriate amounts of resin cement at their margins, or well-fitting but poorly seated restorations caused by the use of highly viscous cements often show a dark line stain at the margins.

Breakdown in bonds is occurred either between the cement and the tooth or between the cement and the veneer. If the veneer is not properly etched or if the veneer and tooth are in some way contaminated during the bonding process, it is possible to experience this problem complete delamination or debonding of the veneer.

There are many clinical evaluations of success and failure of porcelain laminate veneer. Most studies show high percent successful of veneer restoration.

Alhekeir DF et al., 2014 evaluated factors related to the patient, material, and operator with failure of porcelain laminate veneers. In the clinical examination, bleeding on probing was found in 69 % of patients. Also, 0.5-mm. gingival recessions was found 41.4 %. Failure of Restoration was found 34.8 %, especially color change (60 %). However, most patients were satisfied with their restorations about 82.8 %.

They concluded that insufficient clinical skills or operator experience had effect to the failure of restoration.[42]

Fradeani M et al., 2005 evaluated of 182 veneers placed for 12 years. The criteria to determine the survival rate of porcelain laminate veneers are color match, porcelain surface, marginal discoloration, marginal integrity. The clinical performance, failure of restoration was 5.6 % from fracture. However, the porcelain veneers were associated with a high survival rate (94.4 % at 12 years). Color match (96 %), and marginal integrity (92 %) were mostly satisfactory. Marginal discoloration was rated as acceptable (86 %).[12]

D'Arcangelo C et al., 2012 evaluated the clinical performance of 119 porcelain veneers bonded with a light- cured composite over a period of 7 years. They found that when following a protocol of tooth supragingival preparation, cementation technique using a light-cured composite with the constant use of rubber dam isolation and a careful hand finishing was associated with high survival rates of porcelain veneers. These veneers showed promising survival rate of 97.5 %.[43]

Table 1: Summary survival and failure outcomes for Clinical Veneers studies.

Study	Meth-od	Time	No. of veneers	Success	Failure
Peumans M et al., 1998[8]	Prospective cohort	5 yr.	87 veneers	93 %	7%; caries recurrence (2.3 %), porcelain fracture (1.2%), severe clinical microleakage (1.2 %)
Peumans M et al., 2004[13]	Prospective cohort	10 yr.	87 veneers	93 %	Fractures of porcelain (11 %), large marginal defects (20 %), severe marginal discoloration (19 %) and caries recurrence (10 %)
Fradeani M et al., 2005[12]	Retrospective cohort	12 yr.	182 veneers	94.4 %	5.6 % failure
Layton D et al., 2007[44]	Prospective cohort	16 yr.	304 veneers	>73 %	Esthetic (31 %), Loss of retention (12.5 %), Caries (6 %), mechanical (31 %)
Granell-Ruiz M et al., 2010[45]	Prospective cohort	3-11 yr.	323 veneers	94 %	Marginal recession (7.7 %), Bleeding on probing (21.6 %), hypersensitivity and caries (3.1 %). Marginal discoloration (39.3 %), Fractures (4 %) and Decementation (9 %)
D'Arcangelo C et al., 2012 [43]	Prospective cohort	7 yr.	119 veneers	97.5 %	Marginal defect (2.5 %), marginal discoloration (4.2 %), 6.7 % chipping.
Layton DM et al., 2013[46]	Systemic review	>5 yr.	10 studies	76-98 %	-
Gresnigt MM et al., 2013[47]	Prospective cohort	40 months	92 veneers	94.6 %	Slight marginal defects (16 of 87 laminates) and slight marginal discoloration (12 of 87 laminate)

Clinical evaluation of restoration

1 .Modified United States Public Health Service (USPHS) Ryge Criteria

Most studies followed criteria of Modified United States Public Health Service (USPHS) Ryge Criteria [48] for Direct Clinical Evaluation of restorations that consist of

- Color match (Visual inspection)

Alpha (A): The restoration appears to match the shade and translucency of adjacent tooth tissues.

Bravo (B): The restoration does not match the shade and translucency of adjacent tooth tissues, but the mismatch is within the normal range of tooth shades. (Within normal range: Similar to silicate cement restorations for which the dentist did not quite succeed in matching tooth color by his choice among available silicate cement shades.)

Charlie (C): The restoration does not match the shade and translucency of the adjacent tooth structure, and the mismatch is outside the normal range of tooth shades and translucency.

- Cavosurface marginal discoloration (Visual inspection)

Alpha (A): There is no visual evidence of marginal discoloration different from the color of the restorative material and from the color of the adjacent tooth structure.

Bravo (B): There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration, but the discoloration has not penetrated along the restoration in a pulpal direction.

Charlie (C): There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration that has penetrated along the restoration in a pulpal direction.

- Anatomic contour (Visual inspection and explorer)

Alpha (A): The restoration is a continuation of existing anatomic form or is slightly flattened. It may be overcontoured. When the side of the explorer is placed tangentially across the restoration, it does not touch two opposing cavosurface line angles at the same time.

Bravo (B): A surface concavity is evident. When the side of the explorer is placed tangentially across the restoration, it does not touch two opposing cavosurface line

angles at the same time, but the dentin or base is not exposed.

Charlie (C): There is a loss of restorative substance such that a surface concavity is evident and the base and/or dentin are exposed.

- Marginal integrity (Visual inspection and explorer)

Alpha (A): The explorer does not catch when drawn across the surface of the restoration toward the tooth, or, if the explorer does not catch, there is no visible crevice along the periphery of the restoration.

Bravo (B): The explorer catches and there is visible evidence of a crevice, which the explorer penetrates, indicating that the edge of the restoration does not adapt closely to the tooth structure. The dentin and/or the base is not exposed, and the restoration is not mobile.

- Secondary caries (Visual inspection)

Alpha (A): The restoration is a continuation of existing anatomic form adjacent to the restoration.

Bravo (B): There is visual evidence of dark keep discoloration adjacent to the restoration (but not directly associated with cavosurface margins).

- Surface texture (sharp explorer)

Alpha (A): Surface texture similar to polished enamel as determined by means of a sharp explorer.

Bravo (B): Surface texture gritty or similar to a surface subjects to a white stone or similar to a composite containing supramicron-sized particles.

Charlie (C): Surface pitting is sufficiently coarse to inhibit the continuous movement of an explorer across the surface.

- Gross fracture

Alpha (A): Restoration is intact and fully retained.

Bravo (B): Restoration is partially retained with some portion of the restoration still intact.

Charlie (C): Restoration is completely missing.

2. FDI World Dental Federation: clinical criteria for the evaluation of direct and indirect restorations-update [49, 50]

FDI criteria set a different background for the evaluation of dental restorations by introducing three groups of criteria: esthetic, functional and biological. It is composed of 5 scores for each of the different criteria for aesthetic properties (surface luster, marginal staining), functional properties (fracture and retention, marginal adaptation) and biological properties (postoperative sensitivity, recurrence of caries).[50]

Table 2: The esthetic evaluation of FDI criteria.

Esthetic properties	1. Surface luster	2. Surface Staining	3. Color stability	4. Anatomic form
1.Clinically excellent/ very good	1.1 Luster comparable to enamel	2.1 No surface staining	3.1 Good color match. No difference in shade and translucency	4.1 Form is ideal.
2. Clinically good (after polishing very good)	1.2 Slightly dull, not noticeable from speaking distance.	2.2 Minor staining, easily removable.	3.2 minor deviations.	4.2 Form is only slightly affected.
3. Clinically sufficient/satisfactory	1.3 Dull surface but acceptable if covered with film of saliva	2.3 Moderate surface staining, also present on other teeth, not aesthetically unacceptable.	3.3 Clear deviation but acceptable. Does not affect aesthetics: 3.3.1 more opaque 3.3.2 more translucent 3.3.3 darker 3.3.4 brighter	4.3 Form differed but is not aesthetically displeasing.
4. Clinically unsatisfactory (but repairable)	1.4 Rough surface, cannot be masked by saliva film, simple polishing is not sufficient. Further intervention necessary.	2.4 Surface staining present on the restoration and is unacceptable; major intervention necessary for improvement.	3.4 (Localized) clinically unsatisfactory but can be corrected by repair 3.4.1 too opaque 3.4.2 too translucent 3.4.3 too dark 3.4.4 too bright	4.4 Form is affected and unacceptable aesthetically intervention (correction) necessary.
5. Clinically poor	1.5 Quite rough, unacceptable plaque retentive surface.	2.5 Severe staining and/or subsurface staining (generalized or localized);not accessible for intervention)	3.5Unacceptable. Replacement necessary	4.5Form is completely unsatisfactory and/or lost. Repair not feasible/ reasonable, replacement needed.
Overall score	Acceptable aesthetically		Not acceptable	

Table 3: The functional evaluation of FDI criteria.

Functional property	5. Fracture and retention	6. Marginal adaptation	7. Wear	8. Contact point	9. Radiographi-c examination \(when applicable)	10. Patient view
1. Clinically excellent/ very good	5.1 Restoratio n retained, no fractures cracks	6.1 Harmonious outline, no gas, no discoloration.	7.1Physiologi c wear equivalent to enamel (80-120% of correspondi ng enamel)	8.1 Normal contact point (floss or 25 μm. Metal blade of can be inserted but not 50μm blade).	9.1 No pathology, harmonious transition between restoration and tooth	10.1 Entirely satisfied
2. Clinically good (after polishing very good)	5.2 Small hairline crack.	6.2.1Marginal gap (50μm.) 6.2.2 Small marginal fracture removable by polishing.	7.2 Normal wears with only slight difference to enamel (50-80% or 120-150% of correspondi ng enamel).	8.2 Slightly too strong but no disadvantag e.	9.2.1 Acceptable cement excess present 9.2.2 Positive/negativ e step present at margin <150 μm.	10.2 Satisfied
3. Clinically sufficient/ satisfactory	5.3 Two or more or larger hairline cracks and/or chipping (not affecting the marginal integrity or proximal contact.)	6.3.1 Gap<150 μm. Not removable 6.3.2 Several small enamel or dentin fractures.	7.3 Differing wear rate to enamel but within the biological variation (<50% or 150-300% of correspondi ng enamel).	8.3 Slightly too weak, no indication of damage to tooth, gingivae or periodontal structures (50 μm. Metal blade can pass easily	9.3.1 Marginal gap< 200 μm. 9.3.2 Negative steps visible <250 μm. No adverse effects noticed. 9.3.3 Poor radiopacity of filling material.	10.3 Minor criticism of aesthetics 10.3.1 Aesthetic shortcomi ng, 10.3.2 Some lack of chewing comfort

				but not 10 μm)		10.3.3 Time consuming procedure and/or similar; No adverse clinical effect.
4. Clinically unsatisfactory (but repairable)	5.4 Chipping fractures which damage marginal quality or proximal contact; bulk fractures with or without partial loss (less than half of the restoration).	6.4.1 Gap>250 μm. Or dentine/base exposed. 6.4.2 chip fracture damaging margins 6.4.3 Notable enamel or dentin wall fracture.	7.4 Wear considerably exceeds normal enamel wear; or occlusal contact points are lost restoration >300% of enamel wear or antagonist>300%.	8.4 Too weak (100 μm. Metal blade can pass) and possible damage (food impaction). Repair possible.	9.4.1 Marginal gap>250 μm. 9.4.2 Cement excess accessible but not removable. 9.4.3 Negative steps >250 μm and repairable.	10.4 Desire for improvement (reshaping of anatomic form or refurbishing etc.)
5. Clinically poor	5.5 Partial or complete loss of restoration.	6.5 Filling is loose but in situ.	7.5 Wear is excessive (restoration or antagonist>500 % of corresponding enamel).	8.5 Too weak and/or clear damage (food impaction) and/or pain/gingivitis. Requires replacement.	9.5.1 Secondary caries, large gaps 9.5.2 Apical pathology 9.5.3 Fracture/loss of restoration or tooth.	
Overall score	Acceptable aesthetically			Not acceptable		

Table 4: The biological evaluation of FDI criteria.

Biologic properties	11. Postoperative sensitivity	12. Recurrent of caries	13. Tooth integrity	14. Periodontal response	15. Adjacent mucosa	16. Oral and general health
1. Clinically excellent/ very good	11.1 No sensitivity	12.1 No secondary or primary caries	13.1 Complete integrity	14.1 No plaque, no inflammation, no pocket development	15.1 Healthy mucosa adjacent to restoration.	16.1 No oral or general symptoms.
2. Clinically good (after polishing very good)	11.2 Low hypersensitivity for a limited period of time, normal vitality,	12.2 Very small and localized 1.Demineralization 2. Erosion or 3. Abfraction. No operative treatment required.	13.2.1Small marginal enamel split<150 μm 13.2.2 Hairline crack in enamel <150 μm not probable.	14.2 Little plaque, no inflammation (gingivitis), no pocket development.	15.2 Healthy after minor removal of mechanical irritation (sharp edge etc.)	16.2 Minor transient symptoms of short duration (of known or unknown origin) local or generalized)
3. Clinically sufficient/ satisfactory	11.3.1 Premature /slightly more intense. 11.3.2 Delayed/ weak sensitivity; no subjective complaints , no treatment needed.	12.3 Large area of Demineralisation,erosion, or Abrasion/abfraction but only preventive measures necessary9dentine not exposed)	13.3.1 Enamel split <250 μm 13.3.2 crack < 250 μm ; no adverse effect.	14.3.1 Plaque accumulation at acceptable level 14.3.2 Gingival bleeding acceptable. 14.3.3 Pocket formation acceptable,	15.3 Alteration of mucosal but no suspicion of causal relationship with filling material.	16.3 Transient symptoms, local and/or general.

4. Clinically unsatisfactory (but repairable)	11.4.1 Premature/ very intense 11.4.2 Extremely delayed/weak with subjective complaints. 11.4.3 Negative sensitivity intervention necessary but not replacement.	12.4.1Caries with cavitation 12.4.2 Erosion in dentine 12.4.3 Abrasion/abfraction in dentine. Localized and accessible and can be repaired	13.4.1 Major enamel split (gap>250 μm or dentine or base exposed.) 13.4.2 Crack >250 μm (probe penetrates).	14.4.1 Plaque accumulation not acceptable. 14.4.2 Gingival bleeding not acceptable. 14.4.3 Pocket depth increase>1 mm.	15.4 Suspected mild allergic, ichenoid or toxicological reaction.	16.4 Persisting local or general symptoms of oral contact stomatitis or lichen planus or allergic reaction (or remitting). Intervention necessary but no replacement.
5. Clinically poor	11.5 Very intense, acute pulpitis or not vital. Endodontic treatment is necessary and restoration has to be replaced.	12.5 Deep secondary caries or exposed dentine that is not accessible for repair of restoration.	13.5 Cusp or tooth fracture.	14.5 Severe/acute gingivitis or periodontitis.	15.5 Suspected severe allergic, ichenoid or toxicological reaction.	16.5 Acute/severe local or general symptoms.
Overall score	Acceptable aesthetically			Not acceptable		

Score 1 means that the quality of the restoration is excellent/fulfills all quality criteria, and the tooth and/or surrounding tissues are adequately protected. Score 2

should be selected when the quality of the restoration is still highly acceptable, though one or more criteria deviate from the ideal. The restoration could be modified by polishing and upgraded to an 'excellent' rating but this is not normally necessary. There is no risk of damage to the tooth and/or the surrounding tissue; scores 1 and 2 would correspond to Ryge's Alpha rating; score 3 is equivalent to Bravo. Score 3 means that the quality of the restoration is sufficiently acceptable but with minor shortcomings. Because of their location/extent, however these cannot be eliminated without damage to the tooth, though no adverse effects are anticipated. Scores 4 and 5 correspond to Ryge's Charlie and Delta scoring which means that a restoration scored 4 is unacceptable but repairable whereas a restoration scored 5 has to be replaced.[49, 50]

CHAPTER III

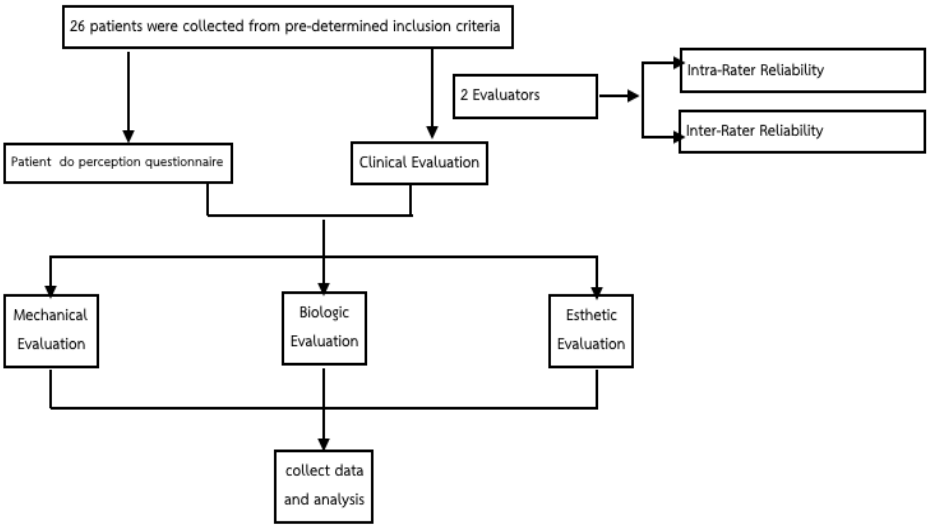
MATERIALS AND METHOD

Research Design

In this retrospective clinical study evaluated ceramic veneers in mechanical, biologic, and esthetic performance. Also, this research includes patient satisfaction. The data was collected from clinical evaluation and questionnaire.

Research Methodology

Diagram of study design



Outcome

The outcome of this study evaluated the success and failure rate of veneer

restorations after placement up to 7 years.

Ethical consideration

Patients were informed of the purpose of this study, and permission was obtained. The Ethical Committee, Faculty of Dentistry, Chulalongkorn University approved the research protocol. If a patient developed complications of any kind from a procedure, appropriate follow-up treatment was performed at no additional cost. All failures in ceramic veneer restorations were retreated or repaired.

Patient selection

From this retrospective study, 163 ceramic veneers were done in 26 patients who underwent veneer therapy for a variety of reasons between 2009 and 2012. All subjects were examined during their regularly maintenance appointments at the Department of Aesthetic Restorative and Implant Dentistry, Chulalongkorn University over a 11-month period from September 2016 to August 2017. The history of the restorations was investigated based on dental chart records. The clinical procedure used was similar. The subjects were treated by graduate students at the Department of Esthetic Restorative and Implant Dentistry, Chulalongkorn University. An expert supervisor controlled all treatment protocols and procedures.

Tooth preparation

All preparations were performed according to the guidelines for tooth preparations approach by the Aesthetic Pre-evaluative Temporary (APT) protocol [27]. For optimal tooth preparation reduction, all types of preparations were based on a mock-up of the final shape and volume of the restoration made from acrylic resin before preparation and also used silicone index derived from a wax-up. The amount of labial enamel reduction was between 0.3 and 0.7 mm. A light chamfered facial finish line was applied in the cervical area and was extended to the midpoint of the interproximal contact area as necessary to hide the restoration margins. The location of the cervical margin was carefully selected for each restoration as preferably equigingivally or subgingivally and not exceeding 0.5 mm. to maintain good periodontal health. Proximal preparation was ended at the contact area. When there were a peg shape or spacing tooth or the restoration was present, the preparation was extended through the contact areas. Incisal finishing line area was the incisal bevel preparation for better aesthetic control at this area and facilitated the seat of the veneer during try-in and cementation[31]. All internal angles were smoothed to reduce stress concentration.

Impression taking

Gingival displacement was obtained using the double retraction cord technique (No. 000, 00 Ultrapack, Ultradent). Following cord removal, the final impression was made by means of a polyvinylsiloxane material (Variotime, Kerr Company). The impression-double mixing technique was used with a light-activated custom tray.

Provisionalisation

Acrylic resin (Luxatemp, Kerr Company) or composite provisional restoration was used for provisionalisation. Provisional restoration thickness was checked to confirm the degree of tooth reduction. The provisional restorations were luted with the spot etch and spot bond technique.

Cementation

Veneer were made with IPS e.max Press (Ivoclar Vivadent) and IPS Empress Esthetic (Ivoclar Vivadent). At the try-in stage, proximal contact, shade match, contour, and marginal adaptation was evaluated for each veneer. Final occlusion was examined after cementation. The color of the restoration was checked using water. If ideal, clear shade cement was used to ensure the best aesthetic result. E.max (Ivoclar Vivadent) ceramic restorations were etched for 20 second with 9.5 % hydrofluoric acid (Porcelain

Etch, Ultradent; Porcelain Etchant, Bisco). Subsequently, the acid was washed with water and dried. A silane agent (Ultradent® Silane, Porcelain Primer, Bisco; Ceramic Primer, 3M) was applied and blown dried on the veneer restorations. The tooth surface was etched for 20-30 seconds with 37 % phosphoric acid (Ultra-etch, Ultradent). After rinsing of the tooth surface with water, dentin adhesive (OptiBond™ Fl, Kerr Company). was applied to the prepared tooth with primer, which penetrated the collagen fibres and promoted the flow of bonding agent. The bonding agent penetrated the collagen net and formed a mixed zone of demineralised dentin and unfilled composite. This zone represents a key factor for the success of dentin bonding.

Light-cured resin composite cement (NX3, Kerr, USA) (Variolink Veneer cement, Ivoclar Vivadent) was used to lute the restorations. This allowed for a longer period of time for the dentist to remove excess cement before curing compared with dual cure or chemically cured materials with superior color stability to dual-cured composites. Excess cement was removed with a brush and dental floss interproximally. The cement was light polymerized from each side for 5 seconds. Excess cement was removed with a blade No.12 and dental floss inter-proximally. The cement was

completely polymerization from each side for 40 seconds. Finally, the occlusion was checked for both centric and eccentric movement. Every patient was recalled one week as baseline in order to observe the oral hygiene, occlusion, gingival response, and to check cement excess after veneer restorations.

Inclusion criteria

Patient received phone call as well as accepted to check up their veneer restorations.

Exclusion criteria

Patient denied to check up their veneer restorations. Also, patient have medical problem which cannot allow to intraoral examination.

Evaluation

1. Patient perception evaluation

The history of the restorations initially was investigated from dental chart records. During first visit evaluation, patient was asking to answer the questionnaire. Patient received questionnaire form (Form 2) to answer the question. The patient's perception classified into Esthetic, Functional, and Biologic perception. Levels of satisfaction were classified as very satisfied, satisfied, neutral, dissatisfied and very

dissatisfied. Esthetic perception was assessed in subterms of Color satisfaction. Functional perception was evaluated in subterms of chewing. Biologic perception was evaluated in subterms of food impaction, tooth brushing/flossing, and gingival bleeding. (Table 5) (Form1)

2. Clinical Evaluation

The history of the restorations initially was investigated from dental records. Two examiners evaluated the veneer restorations. Two examiners calibrated both intra-examiner and inter-examiner before evaluation.

2.1. Intra-examiner calibration

Each examiner performed by evaluation the same criteria, which are mechanical, biologic, and esthetic performance in 5 patients. The following evaluation was being settled after apart from the previous one about 1 week interval. The evaluations repeated 3 times. The results from each evaluation were examined by using intraclass correlation coefficient until they were not significant difference.

2.2. Inter-examiner calibration

Inter-examiner variation could be measured in any situation in which two or more independent examiners were evaluating the same thing. It was also be settled in order to assure that two examiner reported the reliable results. Two examiners performed the calibration. The first examiner evaluated following the criteria from 5 patients, which same as in the intra-examiner calibration, the other examiner evaluated the same veneers as the first examiner. The Kappa coefficient will be carry on until the results of the two examiners was not significant difference. The score must more than 0.8.[51]

The examination used an explorer, mouth mirror, periodontal probe and visual inspection. Photography and data forms were used as documentation tools at this 5 to7-years recall. Esthetic performance assessed clinically at chair side in subterms of Color matching. Mechanical performance evaluated in subterms of Bonding/Debonding, Marginal Discoloration/microleakage, Marginal adaptation and Fracture of restoration. Biologic performance evaluated in subterms of Gingival index, Gingival recession, Secondary caries and Postoperative sensitivity.

Two evaluators recorded the criteria following an index system. Each evaluator provided data separately and took a break every 10 minutes. Each evaluator was asked to stop evaluating every 20 minutes and look away at a distance of 20 feet for 20 seconds.[52]

Criteria for the clinical evaluation

This clinical evaluation criteria modified from United States Public Health Service criteria (USPHS) and World Dental Federation (FDI) criteria that adjusted for veneer restorations. Most studies have followed the criteria of (USPHS) Ryge Criteria for direct clinical evaluation of restoration. It is simplified, making it easy to evaluate the clinical veneer and analyse the results. In contrast, it does not cover all aspects of successful restoration. The authors consider that successful restoration should include an esthetic, mechanical and biological evaluation. World Dental Federation criteria for indirect restoration cover all aspects of evaluation. However, the criteria are difficult to apply clinically and

evaluate veneer restoration from all aspects. Therefore, this study has applied a modification of these criteria to clinically evaluate veneer restoration.

1. Esthetic Evaluation

1. Color Match: Examiners used visual Inspection to evaluate this performance. The criteria composed of 3 grades. [12, 43, 48, 49].The criteria modified from both USPHS and FDI criteria of color matching.

Parameter	Rating	Characteristics
0	Excellent	The restoration matches the shade and translucency of adjacent tooth tissues / veneers restoration. Patient feels very satisfied with color.
1	Acceptable	The restoration does not match the shade or translucency of adjacent tooth/ veneers restoration, but the mismatch is minor deviation within the normal range and clinically acceptable. Patient feels satisfied with color.
2	Unacceptable	The restoration does not match the share or translucency of adjacent teeth/veneers restoration and the mismatch is esthetically displeasing with clinically unacceptable. Patient feels unsatisfied with color.

2. Mechanical Evaluation

2.1 Bonding/Debonding: Examiners use visual Inspection to evaluate this performance.[45] The criteria consists of 2 grades. FDI criteria had no this characteristic. The criteria modified from modified USPHS criteria, which

included in many clinic studies.[8, 13, 44, 45] This criteria had no included in FDI criteria.

Parameter	Rating	Characteristics
0	Excellent	There is no visible evidence of debonding and loss of restoration from tooth surface
1	Unacceptable	There is visible evidence of debonding and loss of restoration from tooth surface.

2.2 Marginal Discoloration: Examiners use visual Inspection to evaluate this performance and blow with triple syringe before evaluateion.[8 47, 49] The criteria followed from USPHS criteria. The criteria consists of 3 grades.

Parameter	Rating	Characteristics
0	Excellent	No visual evidence of marginal discoloration on the margin.
1	Acceptable	Visual evidence of marginal discoloration from slightly staining, which can be polished away.
2	Unacceptable	Visual evidence of marginal discoloration from obvious staining cannot be polished away.

2.3 Marginal adaptation: Examiners use explorer to evaluate this performance and blow with triple syringe before evaluateion.[8, 12, 15, 43, 48, 49] The criteria followed from USPHS criteria. Marginal adaptation parameter of FDI criteria was not practical for clinical evaluation. The criteria consist of 3 grades.

Parameter	Rating	Characteristics
0	Excellent	Smooth surface along margin of restoration There is no catch or penetrate of explorer.
1	Acceptable	There is Slightly discontinuity detectable from explorer with clinical acceptable.
2	Unacceptable	There is an obviously catch or penetrate of explorer and requiring replacement.

2.4 Fracture of Restoration: Examiners use visual Inspection to evaluate this performance. The criteria followed from USPHS criteria. Marginal adaptation parameter of FDI criteria was not practical for clinical evaluation. The criterion consists of 3 grades.[8, 47]

Parameter	Rating	Characteristics
0	Excellent	The restoration is intact and fully retained.
1	Repairable	The restoration is intact with craze line and /or minor chipping of restoration (1/4 of restoration). This fracture can repair or polishing.
2	Irreparable	The restoration is deep crack line/moderate to severe chipping. Replacement is required (1/2 of restoration).

3. Biological Evaluation

First visit evaluation. If patients had moderate to severe plaque and/or calculus deposit, they received Oral health instruction, full mouth scaling and then recheck 1 week. Examiners evaluated in the visit of recheck.

3.1 Gingival Index (Silness and Loe in 1963) Examiners used visual Inspection and periodontal probing to evaluate this performance. The criteria modified from modified USPHS, using gingivival index of Silness and loe to evaluate gingival inflammation. Gingival mucosa parameter of FDI criteria was not practical for clinical evaluation. The criteria composed of 4 grades

Parameter	Rating	Characteristics
0	Absence of Inflammation	Absence of inflammation.
1	Mild Inflammation	Mild inflammation: slight change in color and little change in texture.
2	Moderate Inflammation	Moderate inflammation: moderate glazing, redness, edema, and hypertrophy. Bleeding on probing.
3	Severe Inflammation	Severe inflammation: marked redness and hypertrophy. Tendency to spontaneous bleeding. Ulceration.

3.2 Gingival recession: (modified from Miller Classification[53]) Examiners use visual Inspection and periodontal probe to evaluate this performance. The criteria followed from modified USPHS criteria. There was no this parameter in FDI criteria. The criteria composed of 3 grades.

Parameter	Rating	Characteristics
0	Absence of Recession	No visual evidence of gingival recession from restoration level.
1	Mild Recession	Visual evidence of gingival recession from restoration level to cervical area less than 1 mm. (≤ 1 mm.)
2	Severe Recession	Visual evidence of marginal tissue recession, which extends below restoration more than 1 mm. (> 1 mm.)

3.3 Secondary caries/Recurrent caries: Examiners use visual Inspection to evaluate this performance. The criteria modified from both USPHS and FDI criteria .The criteria composed of 2 grades.[12, 15]

Parameter	Rating	Characteristics
0	Present	No visual evidence of caries contiguous with the margin of the restoration.
1	Absent	Visual evidence of caries at the margin of the restoration.

3.4 Postoperative sensitivity: Examiners asked the patient sign and symptom of postoperative sensitivity each restoration. The criteria modified from both USPHS and FDI criteria. The criteria composed of 2 grades.

Parameter	Rating	Characteristics
0	No History of Hypersensitivity	No symptom of postoperative sensitivity after veneer fixation.
1	History of Hypersensitivity	Present symptom of postoperative sensitivity after veneer fixation.

4 Radiographic Examination: taking periapical radiography each restoration using parallel technique by Rinn XCP.[49] The criteria modified from both USPHS and FDI criteria

Parameter	Rating	Characteristics
0	No Pathologic	No pathologic finding, harmonious transition between restoration and tooth.
1	Pathologic	Present cement excess, and/or marginal gap present and/or sign of secondary caries.

Data collection and analysis

Data was tabulated using Excel 2015 (Microsoft Office Excel 2015, Microsoft). An initial statistical analysis to determine frequencies and percentages for the variable categories was performed using SPSS. All criteria were evaluated including the color matching, bonding/debonding, marginal discoloration, marginal adaptation, fracture, gingival bleeding index, recessions, secondary caries, hypersensitivity, radiograph, and degree of patient satisfaction. In carrying out the statistical analysis, a descriptive approach was taken in analysing the data. Survival rates of the ceramic veneer restorations were evaluated statistically using the Kaplan-Meier test to obtain the cumulative results in relation to observation time. Survival time was defined as the period starting from the successful fitting of the veneer restoration at baseline and

ending when the veneer failed irreparably. The major criteria for irreparable failures included veneers fracture by more than ¼ of restoration and/or debonding and/or impaired aesthetics or function. A P value less than 0.05 was considered to be statistically significant. For further statistical evaluation, the Log-rank test was applied to statistical analysis between: the failure rates of veneers and dental arch.

Table 5: Clinical evaluation modified from USPHS and FDI criteria

Criteria	Parameter	Rating and Restoration Characteristics
Esthetic	Color Matching	0: The restoration matches the shade and translucency of adjacent tooth tissues / veneers restoration. Patient feels very satisfied with color. 1: The restoration does not match the shade or translucency of adjacent tooth/ veneers restoration, but the mismatch is minor deviation within the normal range and clinically acceptable. Patient feels satisfied with color. 2: The restoration does not match the share or translucency of adjacent teeth/veneers restoration and the mismatch is esthetically displeasing with clinically unacceptable. Patient feels unsatisfied with color.
Mechanical	Bonding/Debonding	0: No debonding and loss of restoration from tooth surface. 1: Debonding and loss of restoration from tooth surface.
	Marginal Discoloration	0: No visual evidence of marginal discoloration on the margin. 1: Visual evidence of marginal discoloration from slightly staining, which can be polished away. 2: Visual evidence of marginal discoloration from obvious staining cannot be polished away.
	Marginal Adaptation	0: Smooth margin. No catch or penetrate of explorer. 1: Slightly discontinuity detectable from explorer with clinical acceptable. 2. Catch or penetrate of explorer.
	Fracture of Restoration	0: The restoration is intact and fully retained. 1: The restoration is intact with craze line and /or minor chipping of restoration (1/4 of restoration). This fracture can repair or polishing. 2: The restoration is deep crack line/moderate to

		severe chipping. Replacement is required (1/2 of restoration).
Biologic	Gingival Index	0: Absence of inflammation. 1: Mild inflammation: slight change in color and little change in texture. 2: Moderate inflammation: moderate glazing, redness, edema, and hypertrophy. Bleeding on probing (BOP). 3: Severe inflammation: marked redness and hypertrophy. Tendency to spontaneous bleeding. Ulceration.
	Gingival Recession	0: No visual evidence of gingival recession from restoration level. 1: Visual evidence of gingival recession ≤ 1 mm. 2: Visual evidence of marginal tissue recession >1 mm.
	Postoperative Sensitivity	0: No symptom of postoperative sensitivity after veneer fixation. 1: Present symptom of postoperative sensitivity after veneer fixation.
	Secondary Caries	0: Absent caries. 1: Present caries.
Radiographic Examination	Radiographic Examination	0: No pathologic finding, harmonious transition between restoration and tooth. 1: Present cement excess, and/or marginal gap present and/or sign of secondary caries.

Form 1*:* Recall chart record form.

Recall Chart Record

Code_____HN_____

Gender_____Age_____

Date of insertion_____

Date of recall_____

Patient has recorded history of parafunction

☐ Yes ☐ No

No	Criteria		15	14	13	12	11	21	22	23	24	25
1	Color Matching											
2	Bonding/Debonding											
3	Marginal Discoloration											
4	MarginalAdaptation(Buccal)	Mesial										
		Middle										
		Distal										
5	MarginalAdaptation(Lingual)	Mesial										
		Middle										
		Distal										
6	Fracture of Restoration											
7	Gingival Index											
8	Gingival Recession											
9	Postoperative Sensitivity											
10	Secondary Caries											
11	X-ray											

No	Criteria		35	34	33	32	31	41	42	43	44	45
1	Color Matching											
2	Bonding/Debonding											
3	Marginal Discoloration											
4	Marginal Adaptation (Buccal)	Mesial										
		Middle										
		Distal										
5	Marginal Adaptation (Lingual)	Mesial										
		Middle										
		Distal										
6	Fracture of Restoration											
7	Gingival Index											
8	Gingival Recession											
9	Postoperative Sensitivity											
10	Secondary Caries											
11	X-ray											

Form 2: Questionnaire form.

Questionnaire

Code_____ Sex_____ Age _____

Volunteer accepts all procedures of the study and accept to answer the questionnaire.

General Information: Please write the ✔☐in the box.

1. Do you smoking? ☐ Yes ☐ No

2. Do you drink coffee and/or tea? ☐ Yes ☐ No

Patient perception

Example: You score degrees of satisfy of restoration related to that topic. You should give a mark on the line as show below.

1. Are you satisfied with the color of restoration?

   Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

2. Are you satisfied with the shape both width and height of restoration?

   Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

3. Are you satisfied with daily chewing after veneer placement?

   Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

4. Do you have any problems with food impaction around your veneer restoration?

   Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

5. Do you have any problems with bleeding gums or swelling around the area of veneer restoration?

Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

6. Do you have any problems while cleaning the restoration with a toothbrush and/or dental floss after veneer placement?

Please specify your problem_____

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Veneer Cementation	☐	☐	☐	☐	☐
Nowadays	☐	☐	☐	☐	☐

CHAPTER IV

RESULTS

Results

1. Demographic

In this study, 163 ceramic veneers were placed in 26 patients. The mean observation time was 64 ± 12.5 months. 88.5 % of patients (n= 23) with 85.3 % of total veneers (n=139) were female. 11.5 % of patients (n=3) with 14.7 % of total veneers (n= 24) were male. The age of the patients ranged from 23 to 61 years. The mean age was 44 ± 8.8 years (Table 6).

Patient received between 1 and 20 veneers (mean: 6.6 ±5.7veneers per patient). The distribution of 1-5 veneers were 48.1 %(n=13), 6-10 veneers were 22.2 % (n=6), 11-15 veneers were 14.8 %(n=4), 16-20 veneers were 11.1 %(n=3). The ceramic veneers were prepared on both maxillary and mandibular teeth, which most of them were fitted on maxillary anterior teeth. 69.3 % of veneers (n= 113) were placed on maxillary teeth. 30.7 % of veneers (n=50) were placed on mandibular teeth (Table 6) (Fig 1) (Fig 2).

Patients who treated veneers in this study had no history of parafunction habit. From questionnaire, 100 % (n=26) do not smoking, 53.8 % of patients (n=14) drink coffee and/or tea

Table 6: Patient demographics for veneer restoration

Description		Number	Percent
	Number of Patient	26	100.0
Gender			
	Male	3	11.5
	Female	23	88.5
Age			
	20-30	5	18.5
	31-40	4	14.8
	41-50	11	40.7
	51-60	5	18.5
	>61	1	4.0
Smoking Status			
	Yes	-	-
	No	26	100
Coffee/Tea Consumption			
	Yes	14	53.8
	No	12	46.2
Number of Veneer			
	Placed in 2009	22	13.5
	Placed in 2010	65	39.9
	Placed in 2011	27	16.6
	Placed in 2012	49	30.1
Distribution of teeth			
	Maxillary Central Incisor	41	25.2
	Maxillary Lateral Incisor	32	19.6
	Maxillary Canine	17	10.4
	Maxillary First Premolar	16	9.8
	Maxillary Second premolar	8	5.0
	Mandibular Central Incisor	12	7.4
	Mandibular Lateral Incisor	12	7.4
	Mandibular Canine	12	7.4
	Mandibular First Premolar	9	5.6
	Mandibular Second premolar	4	2.4

Figure 1: Distribution of teeth treated with ceramic veneers.

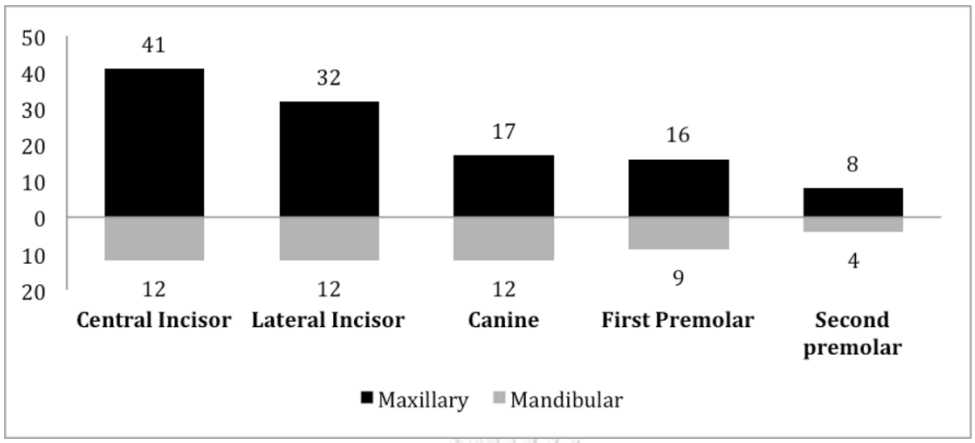


Figure 2: Ceramic veneer restorations

Veneer restorations at the Department of Esthetic Restorative and Implant Dentistry Program, Chulalongkorn University

A: 11, 21 ceramic veneer restorations at 5 years recall.

B: 13-23 ceramic veneer restorations at 6 years recall.

C: 12-22 ceramic veneer restorations at 7 years recall.

D: 12, 22 ceramic veneer restorations at 6 years recall.

Table 7: The distribution of clinical evaluation of veneer restorations (number of restorations and percent)

Clinical Evaluation		Number (percentage) at study checkpoint			
Criteria		0	1	2	3
Esthetic	Color Matching	162 (99.4%)	-	-	
Mechanical	Debonding	162 (99.4%)	1 (0.6%)*		
	Marginal Discoloration	161 (98.8%)	1 (0.6%)	-	
	Marginal Adaptation	154 (94.5%)	8 (4.9%)	-	
	Fracture	157 (96.3%)	2 (1.2%)	3 (1.8%)**	
Biological	Gingival Index	132 (81%)	5 (3.1%)	25(15.3%)	-
	Gingival Recession	146 (89.6%)	16 (9.8%)	-	
	Sensitivity	142 (87.1%)	20 (12.3%)		
	Caries	162 (99.4%)	-		
Radiographic	Radiographic Examination	161 (98.8%)	1 (0.6%)		

*There was 1 veneer restoration showed debonding on the left maxillary second premolar, which had been placed for 7 years ago.

**There were 3 veneer restorations required replacement for more than half of the fracture restoration at the maxillary lateral incisor, maxillary second premolar and lower first premolar.

2. Esthetic Evaluation

The esthetic parameter color match was evaluated as excellent for all intact veneers after 5 to 7 years. No veneers exhibited unacceptable color matching (Table 7) (Fig. 2).

3. Mechanical Clinical Evaluation

Mechanical evaluation included bonding/debonding, marginal discoloration, marginal adaptation and fracture. After 5 to 7 years, 99.4 % of the veneer restorations (n=162) were still intact with the teeth, while only 0.6 % (n=1) showed debonding on the left maxillary second premolar, which had been placed for 7 years ago (Table 7) (Fig. 3).

A total of 98.8 % of the veneer restorations (n=161) showed no marginal discoloration. One veneer (0.6 %) showed visual evidence of marginal discoloration from slight staining, which was able to be polished away at the palatal side of the maxillary central incisor (11).

A total of 94.5 % of the veneer restorations (n=154) presented excellent marginal adaptation, with only 4.9 % (n=8) showing slight discontinuity detectable by

the dental explorer with clinically acceptable marginal adaptation (Table 7). The midpalatal area was the most common for a slightly discontinuous detectable margin (4.3 %) (Table 8)

A total of 96 % of the veneer restorations (n=157) showed excellent fracture evaluation and were still intact and fully retained, with 1.2 % (n=2) intact with craze lines and/or minor chipping (1/4 of restoration) at the mandible canine and maxillary second premolar. In contrast, 1.8 % (n=3) required replacement for more than half of the fracture restoration at the maxillary lateral incisor, maxillary second premolar and lower first premolar (Table 7) (Fig. 4). Fracture of restorations displayed at the cervical area. The cause of the fracture for one lateral incisor was an accidentally inserted oral tube by a medical surgeon, while others were of unknown cause.

Figure 3: Debonding of veneer restoration at 6 years recall on second maxillary premolar tooth

Figure 4: Ceramic Veneer Fracture

A: Irreparable fracture of ceramic veneer at 5 years recall on right mandibular premolar tooth

B: Repairable fracture of ceramic veneer at 6 years recall on right mandibular canine

C: Irreparable fracture of ceramic veneer at 5 years recall on left maxillary premolar tooth

D: Repairable fracture of ceramic veneer at 5 years recall on right maxillary premolar tooth

Table 8: Distribution of marginal adaptation area

Evaluation	Distobuccal	Midbuccal	Mesiobuccal	Distopalatal	Midpalatal	Mesiopalatal
Excellent	162 (99.4%)	160 (98.2%)	159 (97.5%)	162 (99.4%)	155 (95.1%)	162 (99.4%)
Acceptable	-	2 (1.2%)	3 (1.8%)	-	7 (4.3%)**	-
Unacceptable	-	-	-	-	-	-
Total	163	163	163	163	163	163

4. Biologic clinical evaluation

Biological evaluation consisted of gingival index, gingival recession, postoperative sensitivity and caries evaluation. No teeth showed severe gingival inflammation, while 3.1 % (n=5) showed mild gingival inflammation and 15.3 % (n=25) showed moderate gingival inflammation (Table 7). The most common tooth showing moderate gingival inflammation was the left maxillary central incisor (Fig 5).

A total of 89.6 % of veneer restorations (n=146) showed no gingival recession and 9.8 % (n=16) showed gingival recession of less than 1 mm. (Table 7) (Fig 6). A total of 87.1 % of veneer restorations (n=142) showed no sign of hypersensitivity, whereas 12.3 % (n=20) showed a history of hypersensitivity after cementation, which later disappeared. Caries evaluation showed that all veneer restorations were free of caries (Table 7).

Figure 5: The distribution of teeth showed moderate gingival inflammation.

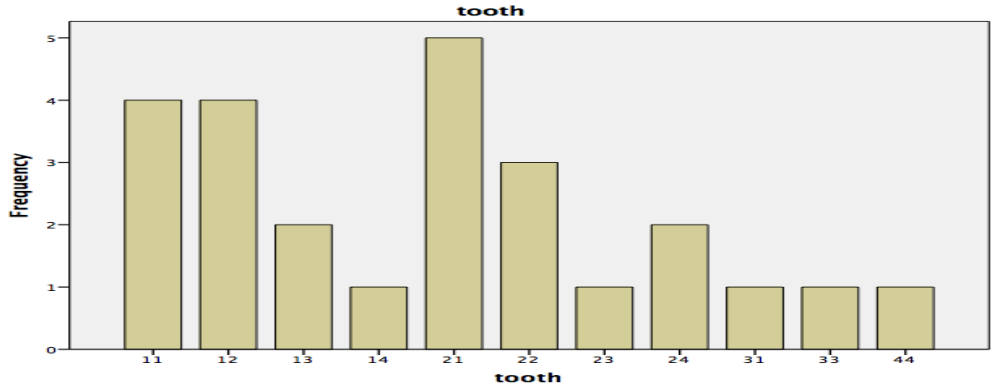
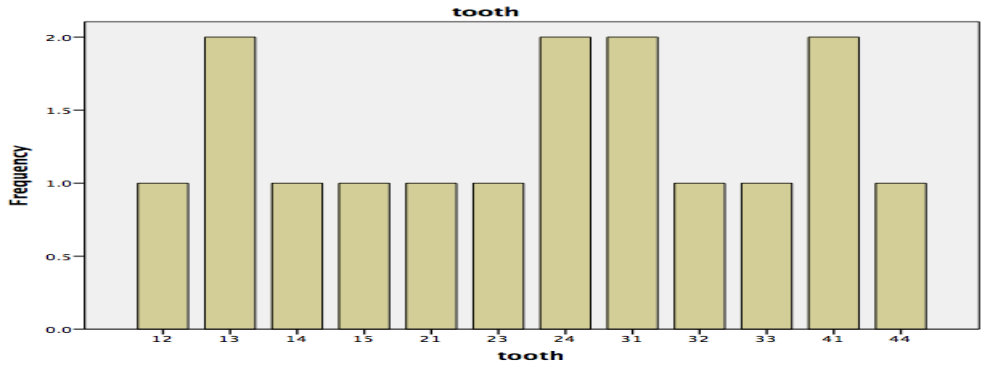


Figure 6: The distribution of teeth showed gingival recession.



5. Radiographic Evaluation

98.2% of veneer restorations (n=160) showed no pathologic finding, harmonious transition between restoration and tooth. One patient had irreversible pulpitis in one tooth (lateral incisor, #12) after veneer placement (Fig 7).

Figure 7: Periapical lesion on lateral central incisor (12).

A: Periapical film of lateral incisor before placed veneer restoration in 2012.

B: Periapical film of lateral incisor after placed veneer restoration on examination in 2017.

6. Patient satisfaction

Esthetic satisfaction evaluation consisted of color and shape. 65.4% of patient felt very satisfy with shape, 23.1 % felt satisfy and 11.5 % feel normal with shape. 65.4 % of patient felt very satisfy with color, 26.9 % felt satisfy and 7.7 % feel normal with color. Functional satisfaction evaluation consisted of chewing problem, and food impaction problem. 100 % of patient had no problem with chewing, 84.6 % of patient felt very satisfy with chewing and 15.4 % felt satisfy with chewing. Also, 100 % of patient had no problem with food impaction, 57.7 % of patient felt very satisfy, and 42.3 % felt satisfy (Table 9). Wilcoxon signed-rank test was utilized to compare

patients' perception between cementation date and evaluation date in each topic. There were no statistically significantly at a 95 % confidence level in every aspect ($P<0.05$) (Table 10).

Table 9: Frequency Distribution of patient's perception

Level	Criteria					
	Esthetic		Functional		Biologic	
	Color	Shape	Chewing	Food Impaction	Gingival Bleeding	Flossing
Very Satisfy	65.4 (n=17)	65.4 (n=17)	84.6 (n=22)	57.7 (n=15)	65.4 (n=17)	65.4 (n=17)
Satisfy	26.9 (n=7)	23.1 (n=6)	15.4 (n=4)	42.3 (n=11)	26.9 (n=7)	30.8 (n=8)
Neutral	7.7 (n=2)	11.5 (n=3)	-	-	7.7 (n=2)	3.8 (n=1)
Dissatisfied	-	-	-	-	-	-
Very Dissatisfied	-	-	-	-	-	-

Table 10: Patients' perception (mean ± standard deviation and P-value)

Topic	Level of Satisfaction		P - value (2-tailed)
	Cementation Date	Evaluation Date	
Color	1.3 ±0.54	1.4± 0.64	0.18
Shape	1.4 ±0.64	1.46 ±0.70	0.56
Chewing	1.2±0.40	1.1±0.37	0.32
Food impaction	1.4 ±0.50	1.4±0.53	1.00
Gingival Bleeding	1.4±0.64	1.4±0.64	1.00
Flossing	1.4 ±0.57	1.4±0.49	1.00

7. The survival rate of veneer

Overall, the survival of the 163 veneer restorations was 97.5% (±0.34), as shown in Fig. 8 (Table 11), with 4 failures caused by 1 debonding and 3 fractures, which were replaced. New restorations were not included in subsequent evaluations. Statistical evaluation revealed that no statistical differences existed between the failure rates of veneers placed in upper and lower teeth (p = 0.86) (Fig. 9) (Table 12) (Table 13). However, veneer placement in the premolar area showed a clear tendency toward an increased risk of fracture.

Table 11: Cumulative success rate of veneer restorations

Total N	N of Events	Success	
		N	Percent
163	4	159	97.5%

Figure 8: Kaplan-Meire analysis, showing estimated cumulative survival of veneer restorations

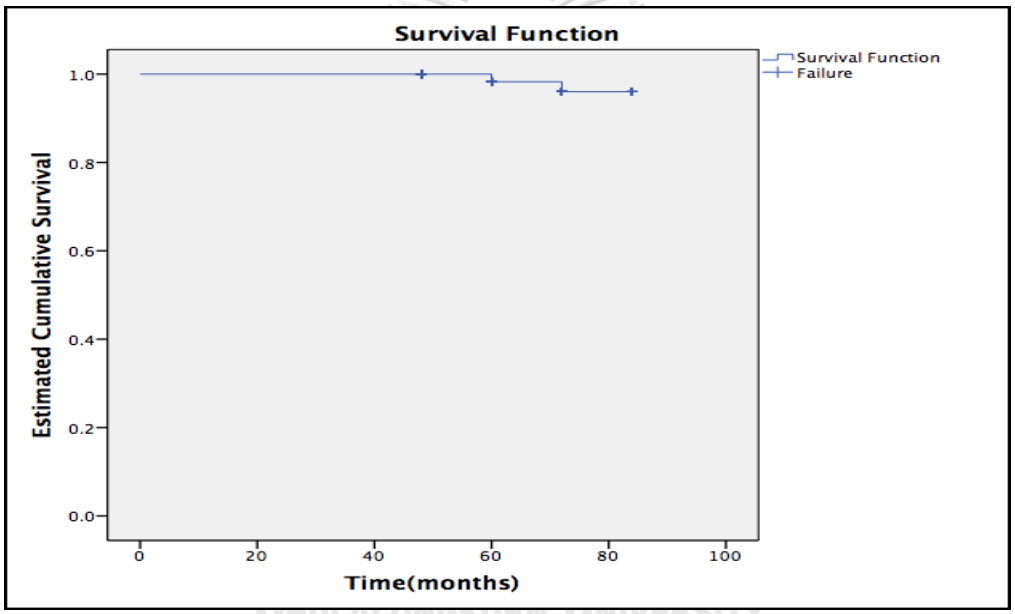


Figure 9: Kaplan-Meire analysis, showing estimated cumulative survival of veneer restorations with dental arch

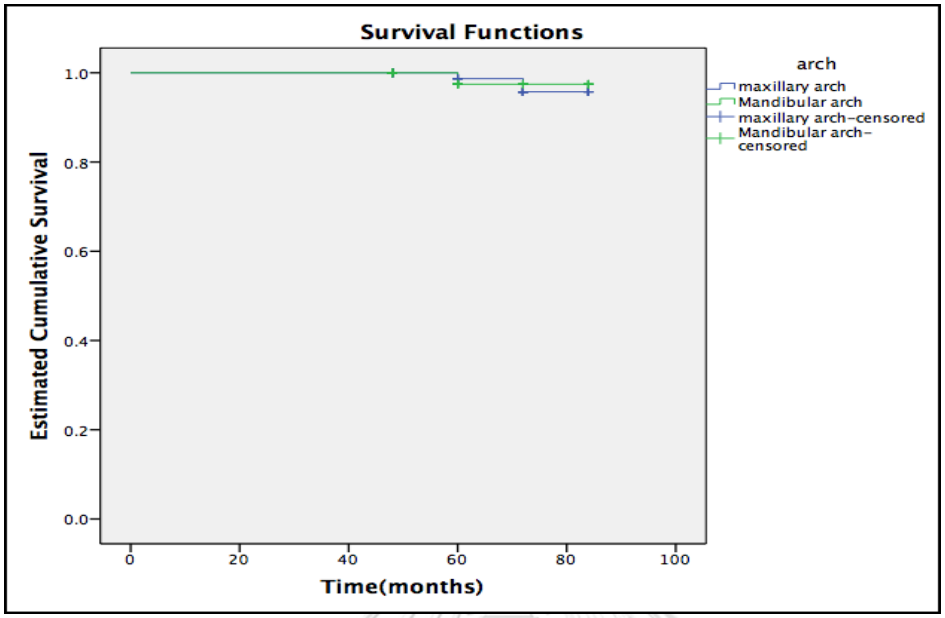


Table 12: Log-Rank test compared between veneer restorations with dental arch

	Chi-Square	Degree of freedom	Significance
Log Rank (Mantel-Cox)	.030	1	.862

Test of equality of survival distributions for the different levels of arch.

Table 13: Cumulative survival rate of veneer restorations each dental arch

Case Processing Summary

Arch	Total No.	No. of Events	Censored	
			No.	Percent
Maxillary arch	113	3	110	97.3%
Mandibular arch	50	1	49	98.0%
Overall	163	4	159	97.5%

CHAPTER V

DISCUSSION AND CONCLUSION

Discussion

Recently, ceramic veneer restorations have gained respect as a durable and viable conservative restorative treatment method. Numerous studies have investigated the behavior of ceramic veneers to evaluate the success and failure of restorative materials under intraoral conditions. Retrospective studies can provide a reliable observation of the clinical performance of veneer restoration.

In this study, the cumulative success rate was 97.5 % after 5 to 7 years, which concurred with other studies showing high 91 %-100 % success rates of ceramic veneer restorations including 5-year clinical results of porcelain veneers by Peumans et al. [8] (93 % on 87 veneers in 25 patients), clinical results of 323 porcelain laminate veneers by Granell-Ruiz et al. [45] (94 % at 3 to 11 years), clinical quality of 191 ceramic veneers by Dumfahrt and Schaffer [54] (97 % at 5 years and 91 % at 10.5 years), 6 to 12-year clinical results of Fradeani et al. [12] (94.4 % of 182 veneers) and clinical observations of 92 ceramic veneers by Gresnigt et al. [47] (94.6 % at 3.3 years in 20 patients). These

results, however, greatly differ from some study. [13, 42]

Esthetic evaluation

This study determined that all ceramic veneers still intact with teeth showed excellent aesthetic results of color matching, similar to reports in other clinical trials.[13, 54, 55] Also, most patients felt very satisfied (65.4 %) with color matching. There were no statistically significant color changes between cementation date and evaluation date. Compared to other habits, no relationship was noted between coffee, tea and/or soft drink consumption and color change.

The key to success for aesthetic results was good color matching. Opacity, translucency, characteristics and color distribution of the existing teeth should be communicated thoroughly to the technician by intraoral and extraoral photographs, shade and characteristic drawings and custom shade (the stump shade). [2, 18, 27] Also, resin cement was selected as light-cured resin cement had superior color stability compared with dual-cured. [2, 56] The main cause of color instability of dual-cured resin cement is oxidation of the amine coinitiator, which is prone to degradation, while the coinitiator in the light-cured resin cement is usually aliphatic and more chemically

stable resulting in less color variation. [18, 57] Turgut and Bagis [57] evaluated different types and shades of resin cement and different thicknesses and shades of veneer restorations. They concluded that the type and shade of resin cement affected the final color of veneer restorations and the effect decreased when the ceramic thickness increased. Moreover, the ceramic used for the restoration is often easily finished and polished and its glazed surface is mostly impervious to extrinsic staining. [18]

Mechanical clinical evaluation

One veneer (1.2%) presented debonding as the maxillary second premolar. This result was comparable to other studies. Beier et al. [58] showed debonding at 9.6 % (n=2), Simeone and Gracis [59] showed 5.5 % (n=15) and Alhekeir et al. [42] showed 10.3 % (n=3). Some authors reported high incidences of decementation of the restorations due to the existence of composite restorations, which decreased the bond strength of the porcelain veneer–tooth complex. [2, 54] Granell-Ruiz et al.[60] found that 9 % (n=29) of debonding of 323 veneer restorations corresponded to patients with bruxism, and to teeth with large composite restoration, and less enamel to which the restoration must be cemented. Moreover, if the veneer is not properly etched or if the veneer and

tooth are in some way is hard to manipulated moisture contaminated during the bonding process, it is possible to experience this problem or worse the complete delamination of the veneer. Therefore, it is important to pay close attention to the adhesion complex: tooth, luting composite and ceramic.

There was a low rate of marginal discoloration (0.6 %) in one veneer restoration at the palatal site of the maxillary central incisor. These problems seldom occur because all margins are in areas that are easily cleaned, finished and polished at the time of cementation. Also, glazed porcelain surface is mostly impervious to extrinsic stain.[21] However, ill-fitting veneers, which expose excess amounts of resin cement at their margins, or poorly seated restorations from using highly viscous cements can cause a dark line stain at the margins.[18]

The palatoincisal area was the most common for a slightly discontinuous detectable margin (4.3 %) agreeing with Peumans et al. who showed that small marginal defects occurred more frequently at the palatoincisal than the cervical outline.[16]The higher percentage of palatal defects can be explained by wear of the resin cement from occlusion and articulation.

Fractures were the most frequent cause of clinical failure for ceramic veneer restorations and 1.2 % (n=2), although rated as acceptable fracture, showed a small fracture of incisal porcelain at the mandibular canine and maxillary second premolar teeth. These two were recontoured with a superfine diamond and polished with a porcelain polishing kit. In contrast, 1.8 % (n=3) were rated as absolute failures and required replacement of more than half the restoration at the maxillary lateral incisor, maxillary second premolar and lower second premolar teeth. One fracture was caused by an accidental oral tube insertion by the surgeon at the lateral incisor and the other two were caused by trauma not attributed to occlusion-related problems. All were replaced with new ceramic veneers. Most clinical longitudinal studies reported a similar low failure rate resulting from fracture including Peumans et al.[16] 1 % (n=1), Fradeani et al. [12] 5.6 % (n=5) and Guess and Stapppert [61] 2.3 % (n=1). Many factors result in fracture of ceramic veneers including the type of ceramic. This study used pressable lithium disilicate glass ceramic (IPS e.max Press) with high flexural strength (440 MPa), which increases fracture resistance. [62] Also, the preparation technique should preserve the enamel to improve bond strength and fracture resistance. Preparation design in

this study applied the aesthetic pre-evaluative temporary (APT) technique based on mock-up teeth made on an additive diagnostic wax-up from a waxing cast. This allowed greater preparation on the enamel and can prevent unnecessary over preparation and preserve intact enamel to which etched ceramic veneer restorations can most reliably be bonded. [27] Also, patient selection is the key to success, especially regarding parafunctional habit. Parafunction may continue after careful restoration, even after specific guidelines are established with the patient. Consequently, after placing the ceramic restorations, patients who were bruxers were provided with hard acrylic resin occlusal guards to protect the definitive restorations during bruxing. No statistically significant difference was determined between fracture and tooth position; however, veneer placement in the premolar area displayed significantly increased fracture risk. The sample population was limited and future clinical studies should critically address ceramic veneer fracture loading in the premolar area.

The most irreparable fracture of veneer restoration in this study was at the cervical area, which is suspect to high stress with high occlusal loading both centric and eccentric because the dentin-enamel junction at the cervical area is very low. [63-65]

Although the ceramic veneer has an elastic modulus near enamel, the high force can induce stress created fracture in the cervical area. M.R. Matson applied loading to veneer elements and the buccal enamel elements were subjected to maximum compressive stresses. [64] Therefore, the low fracture rate in this study indicated that porcelain veneers are durable restorations when the occlusion and articulation are not pathologic and it is also important to select patients without parafunctional habits.

Biologic clinical evaluation

Gingival responses to the veneers were all in the satisfactory range. The optimal periodontal conditions indicated that preparation procedures were fully respectful of periodontal tissues. Kourkouta concluded that veneer placement had no effect on the gingival index and the vitality and amount of plaque bacteria decreased after placement. The smooth surface texture of glazed ceramic decreased bacterial colonisation and growth, and facilitated plaque removal. [66]

There was one patient recorded hypersensitivity after cementation (12.3 %), which later disappeared. This patient had tetracycline-stained teeth and maybe preparation exposed dentin to mask the discoloration. However, there was no clear correlation

between the existence of high sensitivity and the preparations being in dentin. Presumably, the pain threshold of the individual played a role for describing sensitivity. This result was similar to Granell-Ruiz who found that 3.1% complained hypersensitivity after treatment but such sensitivity seemed to gradually disappear over time. [45]

Evaluation showed all veneer restorations free of caries, comparable to other studies. [47, 54] However, Granell-Ruiz et al. recorded 3.1 % of veneer restorations with secondary caries.[45] To avoid secondary caries, great importance is attributed to preparation margins bound by enamel. Peumans et al. noted that veneers with restoration margins located in composite fillings showed secondary caries incidence of 10 % after 10 years. [13]

Radiographic evaluation

One patient had asymptomatic apical periodontitis in one tooth (lateral incisor, 12) with no symptoms after veneer placement. From study of Granell-Ruiz et al. observed that nine teeth that were vital at the beginning of the treatment became pulp non vital after a few years.[45] Peuman et al. observed that tooth vitality pulpal irritation occurred in two veneered teeth with deep interproximal composite fillings

after approximately three years.[13] There was still unknown the exact cause of the pulpal reaction in this case. This tooth (lateral incisor) had no history of large filling restoration, absence of dental decay, no history of previous orthodontic treatment. The teeth requiring veneer restoration do not normally suffer irreversible pulpal reaction damage from the preparations, even if the cutting is deep into dentin. However, when a combination of potentially caustic factors, such as deep, heavy cutting into dentin, cutting of the dentin and enamel without a coolant and by using dull burs at low revolutions per minute (RPMs) with excessive cutting pressure[67], desiccating from a prolonged blast of air, and allowing contamination of the permeable tubules before cementation is followed by traumatic occlusion, the pulps of patients with a lower physiologic compliance and capacity to recover from injury may become irreversibly inflamed.[68]

Further study

The future clinical studies should critically address ceramic veneer fracture loading in the premolar teeth. Also, the further study should increase sample size to evaluate the failure rate of veneer restorations between upper and lower arch.

Conclusions

Despite the limitations of this retrospective clinical study the following conclusions were drawn: Survival probability of the 163 porcelain veneers according to the Kaplan-Meier survival estimation method was 97.5 % after 5 to 7 years. Most common failures resulted from fracture and debonding. Also, Veneers placed in the premolar area had a higher failure rate. Moreover, Esthetic color matching was mostly rated as excellent for both clinical evaluation and patient satisfaction.

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APPENDIX

Appendix A: Study Protocol and Consent Form Approval

No. 068/2016

Study Protocol and Consent Form Approval

The Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand has approved the following study to be carried out according to the protocol and patient/participant information sheet dated and/or amended as follows in compliance with the **ICH/GCP**

Study Title	: The Longevity of Ceramic veneers: Clinical Evaluation of Mechanical, Biologic, and Esthetic Performances of ceramic veneers up to 7-years retrospective study
Study Code	: HREC-DCU **2016-047**
Study Center	: Chulalongkorn University
Principle Investigator	: Dr. Rapeepan Monaraks
Protocol Date	: May 17, 2016
Date of Approval	: July 5, 2016
Date of Expiration	: July 4, 2018

V. Lertchirakarn

(Associate Professor Dr. Veera Lertchirakarn)
Chairman of Ethics Committee

K. Bhalang

(Assistant Professor Dr. Kanokporn Bhalang)
Associate Dean for Research

*A list of the Ethics Committee members (names and positions) present at the Ethics Committee meeting on the date of approval of this study has been attached (upon requested). This Study Protocol Approval Form will be forwarded to the Principal Investigator.

Approval is granted subject to the following conditions: (see back of the approval)

Appendix B: Cumulative success rate of each veneer restorations.

	Time	Status	Cumulative Proportion Surviving at the Time		N of Cumulative Events	N of Remaining Cases
			Estimate	Std. Error		
1	60.000	failure	.	.	1	162
2	60.000	failure	.988	.009	2	161
3	60.000	success	.	.	2	160
4	60.000	success	.	.	2	159
5	60.000	success	.	.	2	158
6	60.000	success	.	.	2	157
7	60.000	success	.	.	2	156
8	60.000	success	.	.	2	155
9	60.000	success	.	.	2	154
10	60.000	success	.	.	2	153
11	60.000	success	.	.	2	152
12	60.000	success	.	.	2	151
13	60.000	success	.	.	2	150
14	60.000	success	.	.	2	149
15	60.000	success	.	.	2	148
16	60.000	success	.	.	2	147
17	60.000	success	.	.	2	146
18	60.000	success	.	.	2	145
19	60.000	success	.	.	2	144
20	60.000	success	.	.	2	143
21	60.000	success	.	.	2	142
22	60.000	success	.	.	2	141
23	60.000	success	.	.	2	140
24	60.000	success	.	.	2	139
25	60.000	success	.	.	2	138
26	60.000	success	.	.	2	137
27	60.000	success	.	.	2	136
28	60.000	success	.	.	2	135

29	60.000	success	.	.	2	134
30	60.000	success	.	.	2	133
31	60.000	success	.	.	2	132
32	60.000	success	.	.	2	131
33	60.000	success	.	.	2	130
34	60.000	success	.	.	2	129
35	60.000	success	.	.	2	128
36	60.000	success	.	.	2	127
37	60.000	success	.	.	2	126
38	60.000	success	.	.	2	125
39	60.000	success	.	.	2	124
40	60.000	success	.	.	2	123
41	60.000	success	.	.	2	122
42	60.000	success	.	.	2	121
43	60.000	success	.	.	2	120
44	60.000	success	.	.	2	119
45	60.000	success	.	.	2	118
46	60.000	success	.	.	2	117
47	60.000	success	.	.	2	116
48	60.000	success	.	.	2	115
49	60.000	success	.	.	2	114
50	60.000	success	.	.	2	113
51	60.000	success	.	.	2	112
52	60.000	success	.	.	2	111
53	60.000	success	.	.	2	110
54	60.000	success	.	.	2	109
55	60.000	success	.	.	2	108
56	60.000	success	.	.	2	107
57	60.000	success	.	.	2	106
58	60.000	success	.	.	2	105
59	60.000	success	.	.	2	104
60	60.000	success	.	.	2	103
61	60.000	success	.	.	2	102
62	60.000	success	.	.	2	101
63	60.000	success	.	.	2	100

64	60.000	success	.	.	2	99
65	60.000	success	.	.	2	98
66	60.000	success	.	.	2	97
67	60.000	success	.	.	2	96
68	60.000	success	.	.	2	95
69	60.000	success	.	.	2	94
70	60.000	success	.	.	2	93
71	60.000	success	.	.	2	92
72	60.000	success	.	.	2	91
73	60.000	success	.	.	2	90
74	60.000	success	.	.	2	89
75	60.000	success	.	.	2	88
76	72.000	failure	.	.	3	87
77	72.000	failure	.965	.018	4	86
78	72.000	success	.	.	4	85
79	72.000	success	.	.	4	84
80	72.000	success	.	.	4	83
81	72.000	success	.	.	4	82
82	72.000	success	.	.	4	81
83	72.000	success	.	.	4	80
84	72.000	success	.	.	4	79
85	72.000	success	.	.	4	78
86	72.000	success	.	.	4	77
87	72.000	success	.	.	4	76
88	72.000	success	.	.	4	75
89	72.000	success	.	.	4	74
90	72.000	success	.	.	4	73
91	72.000	success	.	.	4	72
92	72.000	success	.	.	4	71
93	72.000	success	.	.	4	70
94	72.000	success	.	.	4	69
95	72.000	success	.	.	4	68
96	72.000	success	.	.	4	67
97	72.000	success	.	.	4	66
98	72.000	success	.	.	4	65

99	72.000	success	.	.	4	64
100	72.000	success	.	.	4	63
101	72.000	success	.	.	4	62
102	72.000	success	.	.	4	61
103	72.000	success	.	.	4	60
104	72.000	success	.	.	4	59
105	72.000	success	.	.	4	58
106	72.000	success	.	.	4	57
107	72.000	success	.	.	4	56
108	72.000	success	.	.	4	55
109	72.000	success	.	.	4	54
110	72.000	success	.	.	4	53
111	72.000	success	.	.	4	52
112	72.000	success	.	.	4	51
113	72.000	success	.	.	4	50
114	72.000	success	.	.	4	49
115	72.000	success	.	.	4	48
116	72.000	success	.	.	4	47
117	72.000	success	.	.	4	46
118	72.000	success	.	.	4	45
119	72.000	success	.	.	4	44
120	72.000	success	.	.	4	43
121	72.000	success	.	.	4	42
122	72.000	success	.	.	4	41
123	72.000	success	.	.	4	40
124	72.000	success	.	.	4	39
125	72.000	success	.	.	4	38
126	72.000	success	.	.	4	37
127	72.000	success	.	.	4	36
128	72.000	success	.	.	4	35
129	72.000	success	.	.	4	34
130	72.000	success	.	.	4	33
131	72.000	success	.	.	4	32
132	72.000	success	.	.	4	31
133	72.000	success	.	.	4	30

134	72.000	success	.	.	4	29
135	72.000	success	.	.	4	28
136	72.000	success	.	.	4	27
137	72.000	success	.	.	4	26
138	72.000	success	.	.	4	25
139	72.000	success	.	.	4	24
140	72.000	success	.	.	4	23
141	72.000	success	.	.	4	22
142	84.000	success	.	.	4	21
143	84.000	success	.	.	4	20
144	84.000	success	.	.	4	19
145	84.000	success	.	.	4	18
146	84.000	success	.	.	4	17
147	84.000	success	.	.	4	16
148	84.000	success	.	.	4	15
149	84.000	success	.	.	4	14
150	84.000	success	.	.	4	13
151	84.000	success	.	.	4	12
152	84.000	success	.	.	4	11
153	84.000	success	.	.	4	10
154	84.000	success	.	.	4	9
155	84.000	success	.	.	4	8
156	84.000	success	.	.	4	7
157	84.000	success	.	.	4	6
158	84.000	success	.	.	4	5
159	84.000	success	.	.	4	4
160	84.000	success	.	.	4	3
161	84.000	success	.	.	4	2
162	84.000	success	.	.	4	1
163	84.000	success	.	.	4	0

Appendix C: Patients' Perception on Esthetic performance.

Patient	Esthetic			
	color		Shape Form	
	Before	After	Before	After
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	1	1	1
5	3	2	3	2
6	2	3	2	3
7	2	3	2	3
8	2	2	2	2
9	1	1	2	2
10	2	2	1	1
11	1	1	1	1
12	2	2	3	3
13	1	1	1	1
14	1	1	2	2
15	1	2	1	1
16	1	1	1	1
17	1	1	1	1
18	1	2	2	2
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	2	2	2	2
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1

Appendix D: Patients' Perception on Functional performance.

Patient	Functional			
	Occlusion		Food Impaction	
	Before	After	Before	After
1	1	1	1	1
2	1	1	1	1
3	2	1	2	2
4	1	1	1	1
5	2	2	2	2
6	1	1	2	2
7	1	1	2	2
8	2	2	2	2
9	1	1	2	2
10	1	1	2	2
11	1	1	1	1
12	1	1	2	2
13	1	1	1	1
14	1	1	2	2
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	2	2	2	2
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	2	2	2	2
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1

Appendix E: Patients' Perception on Biological performance.

Patient	Biological			
	Gum Bleeding		Flossing	
	Before	After	Before	After
1	1	1	1	1
2	2	2	2	2
3	1	1	1	1
4	1	1	1	1
5	2	2	3	2
6	3	3	2	2
7	3	3	2	2
8	2	2	2	2
9	1	1	1	1
10	2	2	2	2
11	1	1	1	1
12	2	2	2	2
13	1	1	1	1
14	2	2	2	2
15	1	1	1	1
16	1	1	1	1
17	1	1	1	1
18	1	1	1	2
19	1	1	1	1
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	2	2	2	2
24	1	1	1	1
25	1	1	1	1
26	1	1	1	1

Appendix F: Clinical Evaluation of veneer restorations on Esthetic evaluation.

Number	Tooth	Color matching	Number	Tooth	Color matching
1	11	0	27	41	0
2	21	0	28	42	0
3	22	0	29	43	0
4	34	0	30	44	0
5	33	0	31	45	0
6	32	0	32	12	0
7	31	0	33	11	0
8	41	0	34	21	0
9	42	0	35	22	0
10	43	0	36	14	0
11	44	0	37	24	0
12	15	0	38	25	
13	14	0	39	15	0
14	13	0	40	14	0
15	12	0	41	13	0
16	11	0	42	12	0
17	21	0	43	11	0
18	22	0	44	21	0
19	23	0	45	22	0
20	24	0	46	23	0
21	25	0	47	24	0
22	35	0	48	25	0
23	34	0	49	35	0
24	33	0	50	34	0
25	32	0	51	33	0
26	31	0	52	32	0

Number	Tooth	Color matching	Number	Tooth	Color matching
53	31	0	80	22	0
54	41	0	81	13	0
55	42	0	82	12	0
56	43	0	83	11	0
57	44	0	84	21	0
58	45	0	85	22	0
59	12	0	86	23	0
60	11	0	87	14	0
61	21	0	88	13	0
62	22	0	89	12	0
63	14	0	90	11	0
64	12	0	91	21	0
65	11	0	92	33	0
66	21	0	93	32	0
67	12	0	94	31	0
68	22	0	95	41	0
69	14	0	96	42	0
70	13	0	97	43	0
71	12	0	98	44	0
72	11	0	99	15	0
73	21	0	100	14	0
74	22	0	101	12	0
75	23	0	102	11	0
76	24	0	103	21	0
77	12	0	104	22	0
78	11	0	105	24	0
79	21	0	106	25	0

Number	Tooth	Color matching	Number	Tooth	Color matching
107	12	0	134	11	0
108	11	0	135	21	0
109	21	0	136	22	0
110	13	0	137	21	0
111	12	0	138	11	0
112	11	0	139	11	0
113	21	0	140	21	0
114	22	0	141	13	0
115	23	0	142	12	0
116	11	0	143	11	0
117	14	0	144	21	0
118	13	0	145	22	0
119	12	0	146	23	0
120	11	0	147	11	0
121	21	0	148	21	0
122	22	0	149	15	0
123	23	0	150	14	0
124	24	0	151	13	0
125	44	0	152	12	0
126	43	0	153	11	0
127	42	0	154	21	0
128	41	0	155	22	0
129	31	0	156	23	0
130	32	0	157	24	0
131	33	0	158	33	0
132	34	0	159	32	0
133	12	0	160	31	0
161	41	0			
162	42	0			
163	43	0			

Appendix G: Clinical Evaluation of veneer restorations on Mechanical evaluation.

Number	Tooth	Bonding	Marginal Defect	Marginal Discoloration	Fracture
1	11	0	0	0	0
2	21	0	0	0	0
3	22	0	0	0	2
4	34	0	0	0	0
5	33	0	0	1	1
6	32	0	0	1	0
7	31	0	0	0	0
8	41	0	0	0	0
9	42	0	0	1	0
10	43	0	0	0	0
11	44	0	0	0	0
12	15	0	0	0	1
13	14	0	0	0	0
14	13	0	0	0	0
15	12	0	0	0	0
16	11	0	0	0	0
17	21	0	0	0	0
18	22	0	0	0	0
19	23	0	0	0	0
20	24	0	0	0	0
21	25	0	0	0	0
22	35	0	0	0	0
23	34	0	0	0	0
24	33	0	0	0	0
25	32	0	0	0	0
26	31	0	0	0	0
27	41	0	0	0	0
28	42	0	0	0	0
29	43	0	0	0	0
30	44	0	0	0	0
31	45	0	0	0	0

32	12	0	0	0	0
33	11	0	0	0	0
34	21	0	0	0	0
36	14	0	0	0	0
37	24	0	0	0	0
38	25	1			
39	15	0	0	0	0
35	14	0	0	0	0
40	13	0	0	0	0
41	12	0	0	0	0
42	11	0	0	0	0
43	21	0	0	0	0
44	22	0	0	0	0
45	23	0	0	0	0
46	24	0	0	0	0
47	25	0	0	0	0
48	35	0	0	0	0
49	34	0	0	0	0
50	33	0	0	0	0
51	32	0	0	0	0
52	31	0	0	0	0
53	41	0	0	0	0
54	42	0	0	0	0
55	43	0	0	0	0
56	44	0	0	0	2
57	45	0	0	0	0
58	12	0	0	0	0
59	11	0	0	1	0
60	21	0	0	0	0
61	22	0	0	0	0
62	14	0	0	0	0
63	12	0	0	0	0
64	11	0	0	0	0
65	21	0	0	0	0

66	12	0	0	0	0
67	12	0	0	0	0
68	22	0	0	0	0
69	14	0	0	0	0
70	13	0	0	0	0
71	12	0	0	0	0
72	11	0	0	0	0
73	21	0	0	1	0
74	22	0	0	0	0
75	23	0	0	0	0
76	24	0	0	0	0
77	12	0	0	0	0
78	11	0	0	1	0
79	21	0	0	0	0
80	22	0	0	1	0
81	13	0	0	0	0
82	12	0	0	0	0
83	11	0	0	0	0
84	21	0	0	0	0
85	22	0	0	0	0
86	23	0	0	0	0
87	14	0	0	0	0
88	13	0	0	0	0
89	12	0	0	0	0
90	11	0	1	0	0
91	21	0	0	0	0
92	33	0	0	0	0
93	32	0	0	0	0
94	31	0	0	0	0
95	41	0	0	0	0
96	42	0	0	0	0
97	43	0	0	0	0
98	44	0	0	0	0
99	15	0	0	0	0

100	14	0	0	0	0
101	12	0	0	0	0
102	11	0	0	0	0
103	21	0	0	0	0
104	22	0	0	0	0
105	24	0	0	0	2
106	25	0	0	0	0
107	12	0	0	0	0
108	11	0	0	0	0
109	21	0	0	0	0
110	13	0	0	0	0
111	12	0	0	0	0
112	11	0	0	0	0
113	21	0	0	0	0
114	22	0	0	0	0
115	23	0	0	1	0
116	11	0	0	0	0
117	14	0	0	0	0
118	13	0	0	0	0
119	12	0	0	0	0
120	11	0	0	0	0
121	21	0	0	0	0
122	22	0	0	0	0
123	23	0	0	0	0
124	24	0	0	0	0
125	44	0	0	0	0
126	43	0	0	0	0
127	42	0	0	0	0
128	41	0	0	0	0
129	31	0	0	0	0
130	32	0	0	0	0
131	33	0	0	0	0
132	34	0	0	0	0
133	12	0	0	0	0

134	11	0	0	0	0
135	21	0	0	0	0
136	22	0	0	0	0
137	21	0	0	0	0
138	11	0	0	0	0
139	11	0	0	0	0
140	21	0	0	0	0
141	13	0	0	0	0
142	12	0	0	0	0
143	11	0	0	0	0
144	21	0	0	0	0
145	22	0	0	0	0
146	23	0	0	0	0
147	11	0	0	0	0
148	21	0	0	0	0
149	15	0	0	0	0
150	14	0	0	0	0
151	13	0	0	0	0
152	12	0	0	0	0
153	11	0	0	0	0
154	21	0	0	0	0
155	22	0	0	0	0
156	23	0	0	0	0
157	24	0	0	0	0
158	33	0	0	0	0
159	32	0	0	0	0
160	31	0	0	0	0
161	41	0	0	0	0
162	42	0	0	0	0
163	43	0	0	0	0

Appendix H: Clinical Evaluation of veneer restorations on Marginal defect each side of tooth.

No.	Tooth	Mesio-buccal	Mid-buccal	Disto-buccal	Mesio-palatal	Mid-palatal	Disto-palata
1	11	0	0	0	0	0	0
2	21	0	0	0	0	0	0
3	22	0	0	0	0	0	0
4	34	0	0	0	0	0	0
5	33	0	1	0	0	0	0
6	32	0	0	0	0	1	0
7	31	0	0	0	0	0	0
8	41	0	0	0	0	0	0
9	42	0	1	0	0	1	0
10	43	0	0	0	0	0	0
11	44	0	0	0	0	0	0
12	15	0	0	0	0	0	0
13	14	0	0	0	0	0	0
14	13	0	0	0	0	0	0
15	12	0	0	0	0	0	0
16	11	0	0	0	0	0	0
17	21	0	0	0	0	0	0
18	22	0	0	0	0	0	0
19	23	0	0	0	0	0	0
20	24	0	0	0	0	0	0
21	25	0	0	0	0	0	0
22	35	0	0	0	0	0	0
23	34	0	0	0	0	0	0
24	33	0	0	0	0	0	0
25	32	0	0	0	0	0	0
26	31	0	0	0	0	0	0
27	41	0	0	0	0	0	0
28	42	0	0	0	0	0	0
29	43	0	0	0	0	0	0

30	44	0	0	0	0	0	0
31	45	0	0	0	0	0	0
32	12	0	0	0	0	0	0
33	11	0	0	0	0	0	0
34	21	0	0	0	0	0	0
35	22	0	0	0	0	0	0
36	14	0	0	0	0	0	0
37	24	0	0	0	0	0	0
38	25						
39	15	0	0	0	0	0	0
35	14	0	0	0	0	0	0
40	13	0	0	0	0	0	0
41	12	0	0	0	0	0	0
42	11	0	0	0	0	0	0
43	21	0	0	0	0	0	0
44	22	0	0	0	0	0	0
45	23	0	0	0	0	0	0
46	24	0	0	0	0	0	0
47	25	0	0	0	0	0	0
48	35	0	0	0	0	0	0
49	34	0	0	0	0	0	0
50	33	0	0	0	0	0	0
51	32	0	0	0	0	0	0
52	31	0	0	0	0	0	0
53	41	0	0	0	0	0	0
54	42	0	0	0	0	0	0
55	43	0	0	0	0	0	0
56	44	0	0	0	0	0	0
57	45	0	0	0	0	0	0
58	12	0	0	0	0	0	0
59	11	0	0	0	0	1	0
60	21	0	0	0	0	0	0
61	22	0	0	0	0	0	0
62	14	0	0	0	0	0	0

63	12	0	0	0	0	0	0
64	11	0	0	0	0	0	0
65	21	0	0	0	0	0	0
66	12	0	0	0	0	0	0
67	12	0	0	0	0	0	0
68	22	0	0	0	0	0	0
69	14	0	0	0	0	0	0
70	13	0	0	0	0	0	0
71	12	0	0	0	0	0	0
72	11	0	0	0	0	0	0
73	21	0	0	0	0	1	0
74	22	0	0	0	0	0	0
75	23	0	0	0	0	0	0
76	24	0	0	0	0	0	0
77	12	0	0	0	0	0	0
78	11	0	0	0	0	1	0
79	21	0	0	0	0	0	0
80	22	0	0	0	0	1	0
81	13	0	0	0	0	0	0
82	12	0	0	0	0	0	0
83	11	0	0	0	0	0	0
84	21	0	0	0	0	0	0
85	22	0	0	0	0	0	0
86	23	0	0	0	0	0	0
87	14	0	0	0	0	0	0
88	13	0	0	0	0	0	0
89	12	0	0	0	0	0	0
90	11	0	0	0	0	0	0
91	21	0	0	0	0	0	0
92	33	0	0	0	0	0	0
93	32	0	0	0	0	0	0
94	31	1	0	0	0	0	0
95	41	0	0	0	0	0	0
96	42	0	0	0	0	0	0

97	43	0	0	0	0	0	0
98	44	0	0	0	0	0	0
99	15	0	0	0	0	0	0
100	14	0	0	0	0	0	0
101	12	0	0	0	0	0	0
102	11	0	0	0	0	0	0
103	21	0	0	0	0	0	0
104	22	0	0	0	0	0	0
105	24	0	0	0	0	0	0
106	25	0	0	0	0	0	0
107	12	0	0	0	0	0	0
108	11	0	0	0	0	0	0
109	21	0	0	0	0	0	0
110	13	0	0	0	0	0	0
111	12	0	0	0	0	0	0
112	11	0	0	0	0	0	0
113	21	0	0	0	0	0	0
114	22	0	0	0	0	0	0
115	23	0	0	0	0	1	0
116	11	0	0	0	0	0	0
117	14	0	0	0	0	0	0
118	13	0	0	0	0	0	0
119	12	1	0	0	0	0	0
120	11	0	0	0	0	0	0
121	21	0	0	0	0	0	0
122	22	1	0	0	0	0	0
123	23	0	0	0	0	0	0
124	24	0	0	0	0	0	0
125	44	0	0	0	0	0	0
126	43	0	0	0	0	0	0
127	42	0	0	0	0	0	0
128	41	0	0	0	0	0	0
129	31	0	0	0	0	0	0
130	32	0	0	0	0	0	0

131	33	0	0	0	0	0	0
132	34	0	0	0	0	0	0
133	12	0	0	0	0	0	0
134	11	0	0	0	0	0	0
137	21	0	0	0	0	0	0
138	11	0	0	0	0	0	0
139	11	0	0	0	0	0	0
140	21	0	0	0	0	0	0
141	13	0	0	0	0	0	0
142	12	0	0	0	0	0	0
143	11	0	0	0	0	0	0
144	21	0	0	0	0	0	0
145	22	0	0	0	0	0	0
146	23	0	0	0	0	0	0
147	11	0	0	0	0	0	0
148	21	0	0	0	0	0	0
149	15	0	0	0	0	0	0
150	14	0	0	0	0	0	0
151	13	0	0	0	0	0	0
152	12	0	0	0	0	0	0
153	11	0	0	0	0	0	0
154	21	0	0	0	0	0	0
155	22	0	0	0	0	0	0
156	23	0	0	0	0	0	0
157	24	0	0	0	0	0	0
158	33	0	0	0	0	0	0
159	32	0	0	0	0	0	0
160	31	0	0	0	0	0	0
161	41	0	0	0	0	0	0
162	42	0	0	0	0	0	0
163	43	0	0	0	0	0	0

Appendix I: Clinical Evaluation of veneer restorations on Biological evaluation and X-ray.

No.	Tooth	Gingival Index	Gingival recession	Hypersensitivity	caries	X-ray
1	11	2	0	0	0	0
2	21	0	0	0	0	0
3	22	0	0	0	0	0
4	34	0	0	0	0	0
5	33	0	1	0	0	0
6	32	1	0	0	0	0
7	31	0	1	0	0	0
8	41	1	1	0	0	0
9	42	0	0	0	0	0
10	43	0	0	0	0	0
11	44	0	1	0	0	0
12	15	0	0	1	0	0
13	14	1	0	1	0	0
14	13	0	0	1	0	0
15	12	0	0	1	0	0
16	11	0	0	1	0	0
17	21	0	0	1	0	0
18	22	2	0	1	0	0
19	23	0	0	1	0	0
20	24	0	0	1	0	0
21	25	0	0	1	0	0
22	35	0	0	1	0	0
23	34	0	0	1	0	0
24	33	0	0	1	0	0
25	32	0	0	1	0	0
26	31	0	0	1	0	0
27	41	0	0	1	0	0
28	42	0	0	1	0	0
29	43	0	0	1	0	0
30	44	0	0	1	0	0

31	45	0	0	1	0	0
32	12	0	0	0	0	1
33	11	0	0	0	0	0
34	21	0	0	0	0	0
35	22	0	0	0	0	0
36	14	0	0	0	0	0
37	24	2	0	0	0	0
38	25					
39	15	0	0	0	0	0
35	14	0	1	0	0	0
40	13	0	0	0	0	0
41	12	0	0	0	0	0
42	11	0	0	0	0	0
43	21	0	0	0	0	0
44	22	0	0	0	0	0
45	23	0	0	0	0	0
46	24	0	1	0	0	0
47	25	0	0	0	0	0
48	35	0	0	0	0	0
49	34	0	0	0	0	0
50	33	0	0	0	0	0
51	32	0	0	0	0	0
52	31	0	0	0	0	0
53	41	0	0	0	0	0
54	42	0	0	0	0	0
55	43	0	0	0	0	0
56	44	0	0	0	0	0
57	45	0	0	0	0	0
58	12	2	0	0	0	0
59	11	0	0	0	0	0
60	21	2	0	0	0	0
61	22	0	0	0	0	0
62	14	0	0	0	0	0
63	12	2	0	0	0	0

64	11	0	0	0	0	0
65	21	0	0	0	0	0
66	12	0	0	0	0	0
67	22	0	0	0	0	0
68	22	0	0	0	0	0
69	14	0	0	0	0	0
70	13	0	0	0	0	0
71	12	2	0	0	0	0
72	11	0	0	0	0	0
73	21	0	0	0	0	0
74	22	0	0	0	0	0
75	23	0	1	0	0	0
76	24	0	0	0	0	0
77	12	0	0	0	0	0
78	11	2	0	0	0	0
79	21	0	0	0	0	0
80	22	0	0	0	0	0
81	13	0	0	0	0	0
82	12	0	0	0	0	0
83	11	2	0	0	0	0
84	21	2	0	0	0	0
85	22	0	0	0	0	0
86	23	0	0	0	0	0
87	14	0	0	0	0	0
88	13	2	1	0	0	0
89	12	0	1	0	0	0
90	11	0	0	0	0	0
91	21	0	0	0	0	0
92	33	2	0	0	0	0
93	32	0	0	0	0	0
94	31	2	0	0	0	0
95	41	0	0	0	0	0
96	42	0	0	0	0	0
97	43	0	0	0	0	0

98	44	2	0	0	0	0
99	15	0	1	0	0	0
100	14	2	0	0	0	0
101	12	2	0	0	0	0
102	11	0	0	0	0	0
103	21	2	0	0	0	0
104	22	2	0	0	0	0
105	24	2	0	0	0	0
106	25	0	0	0	0	0
107	12	0	0	0	0	0
108	11	0	0	0	0	0
109	21	0	0	0	0	0
110	13	0	0	0	0	0
111	12	0	0	0	0	0
112	11	0	0	0	0	0
113	21	1	0	0	0	0
114	22	1	0	0	0	0
115	23	2	0	0	0	0
116	11	0	0	0	0	0
117	14	0	0	0	0	0
118	13	2	1	0	0	0
119	12	0	0	0	0	0
120	11	0	0	0	0	0
121	21	2	1	0	0	0
122	22	0	0	0	0	0
123	23	0	0	0	0	0
124	24	0	1	0	0	0
125	44	0	0	0	0	0
126	43	0	0	0	0	0
127	42	0	0	0	0	0
128	41	0	1	0	0	0
129	31	0	1	0	0	0
130	32	0	1	0	0	0

131	33	0	0	0	0	0
132	34	0	0	0	0	0
133	12	0	0	0	0	0
134	11	2	0	0	0	0
137	21	0	0	0	0	0
138	11	0	0	0	0	0
139	11	0	0	0	0	0
140	21	0	0	0	0	0
141	13	0	0	0	0	0
142	12	0	0	0	0	0
143	11	0	0	0	0	0
144	21	0	0	0	0	0
145	22	0	0	0	0	0
146	23	0	0	0	0	0
147	11	0	0	0	0	0
148	21	0	0	0	0	0
149	15	0	0	0	0	0
150	14	0	0	0	0	0
151	13	0	0	0	0	0
152	12	0	0	0	0	0
153	11	0	0	0	0	0
154	21	0	0	0	0	0
155	22	0	0	0	0	0
156	23	0	0	0	0	0
157	24	0	0	0	0	0
158	33	0	0	0	0	0
159	32	0	0	0	0	0
160	31	0	0	0	0	0
161	41	0	0	0	0	0
162	42	0	0	0	0	0

163	43	0	0	0	0	0

Appendix J: Questionnaire in Thai version.

แบบสอบถามสำหรับอาสาสมัคร

รหัส_____เพศ_____ อายุ _____

อาสาสมัคร ได้รับทราบถึงขั้นตอนการทำวิจัยนี้แล้ว และยินยอมที่จะร่วมการทำวิจัยโดยการตอบแบบสอบถามนี้

ข้อมูลทั่วไป: ขอให้ผู้ตอบแบบสอบถามทำเครื่องหมาย ✔☐ในกล่องข้อความตามความเป็นจริง

1. ปัจจุบันนี้ท่านสูบบุหรี่หรือไม่ ☐ใช่ ☐ไม่ใช่
2. ปัจจุบันนี้ท่านดื่มชาและ/หรือกาแฟหรือไม่ ☐ใช่ ☐ไม่ใช่

ระดับความพึงพอใจ

ขอให้ผู้ตอบแบบสอบถาม ให้คะแนนระดับความพึงพอใจสัมพันธ์กับแต่ละหัวข้อ โดยทำเครื่องหมาย ✔ ในกล่อง

1. ท่านมีความพึงพอใจในสีของวัสดุบูรณะวีเนียร์ของท่าน
   โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

2. ท่านมีความพึงพอใจในขนาด รูปร่างและความยาวของวัสดุบูรณะวีเนียร์ของท่าน
   โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

3. ท่านมีความพึงพอใจในการใช้งาน และสามารถบดเคี้ยวอาหารได้ปกติ
   โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

4. ท่านไม่มีปัญหาเรื่องเศษอาหารติดบ่อยครั้งบริเวณฟันที่ได้รับการบูรณะด้วยเซรามิกวีเนียร์ (หากไม่ใช่ โปรดระบุ)

   โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

5. ท่านไม่มีปัญหาเลือดออกตามไรฟันและ/หรือเหงือกบวมรอบๆ บริเวณฟันที่ได้รับการบูรณะด้วยเซรามิกวีเนียร์ (หากไม่ใช่ โปรดระบุ)

   โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

6. ท่านมีปัญหาในการทำความสะอาดด้วยแปรงสีฟัน/ไหมขัดฟัน บริเวณฟันที่ได้รับการบูรณะด้วยเซรามิกวีเนียร์หรือไม่ (หากไม่ใช่

   โปรดระบุ)โปรดระบุปัญหาของท่าน_____

	พอใจมากที่สุด	พอใจ	ปานกลาง	พอใจน้อย	ไม่พอใจ
วันแรกที่ยึดวีเนียร์	☐	☐	☐	☐	☐
ปัจจุบัน	☐	☐	☐	☐	☐

Appendix K: Veneer restoration in each patient.

Ceramic veneer restorations on teeth number 14,13,12,11,21,22,23,24,34,33,32,31,41, 42, 43, 44 were placed in 2009. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding.

Marginal adaptation of all veneer restorations rated as score 0. Marginal discoloration of all veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained. The biological evaluation, right maxillary canine (13) and left maxillary central incisor (21) showed moderate gingival, rated as score 2 (Moderate inflammation: moderate glazing, redness, edema, and hypertrophy. Bleeding on probing). Others showed no gingival inflammation. All veneer restorations had no history of postoperative hypersensitivity, rated as score 0. Gingival recession was found on right mandibular canine (43), left mandibular canine (31), left mandibular later incisor (32), right maxillary lateral incisor (12), rated as score 1. Caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 13,12,11,21,22,23 were placed in 2009. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of most veneer

restorations rated as score 0. Marginal discoloration of right maxillary lateral incisor (12) at palatal area rated as score 1. (Visual evidence of marginal discoloration from slightly staining, which can be polished away). All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation, all veneer restorations showed healthy gingival, rated as score 0. Veneer restorations had no history of postoperative hypersensitivity and no gingival recession. Caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 14,13,12,11,21, 22,23,24 were placed in 2010. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation at midpalatal area of left central incisor (21) rated as score 1. (Slightly discontinuity detectable from explorer with clinical acceptable). Marginal discoloration of left central incisor (21) at palatal area rated as score 1. (Visual evidence of marginal discoloration from slightly staining, which can be polished away). All veneer

restorations were intact with teeth and fully retained. The biological evaluation, all veneer restorations showed no gingival inflammation, no postoperative hypersensitivity and caries rated as score 0. Gingival recession rated as score 1 on left maxillary canine (23) (Visual evidence of gingival recession ≤ 1 mm.). Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 12,11,21,22 were placed in 2010. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation at midpalatal area of right central incisor (11) rated as score 1. (Slightly discontinuity detectable from explorer with clinical acceptable). Marginal discoloration of right central incisor (11) at palatal area rated as score 1. (Visual evidence of marginal discoloration from slightly staining, which can be polished away). All veneer restorations were intact with teeth and fully retained. The biological evaluation, veneer restorations of left lateral incisor

(22) and right central incisor (11) showed no gingival inflammation. However, left maxillary central incisor (21) and right lateral incisor (12) showed moderate gingival inflammation, rated as score 2. Postoperative hypersensitivity, gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

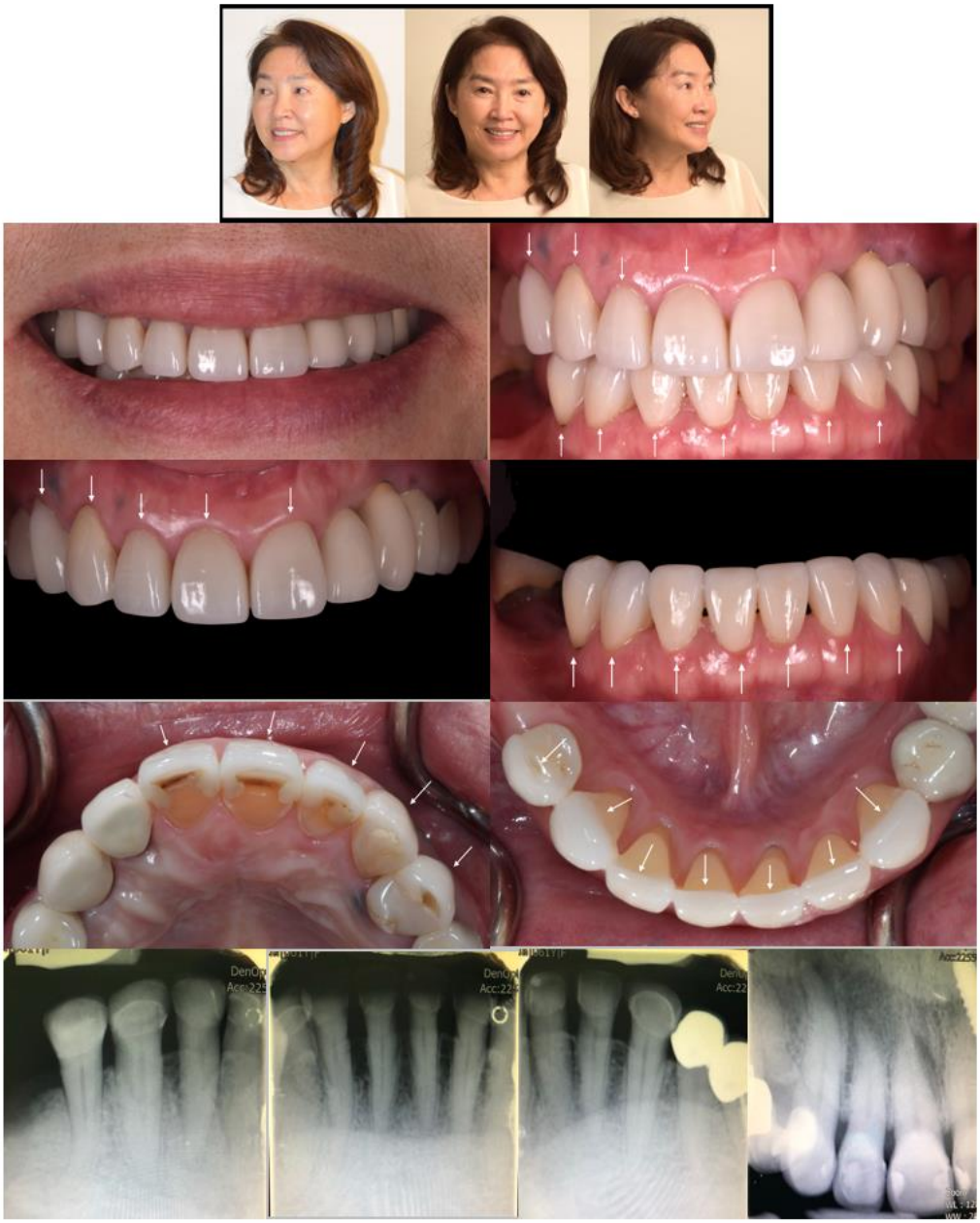
Ceramic veneer restorations on teeth number 15,14,13,12,11,21,22,23,24,25 were placed in 2010. and teeth number 35,34,33,32,3,41,42,43,44,45 were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of all veneer restorations rated as score 0. Marginal discoloration of all veneer restorations rated as score 0. Most veneer restorations were intact with teeth and fully retained. While right mandibular first premolar (44) showed fracture of veneer restoration at cervical area, rated as score 2. The biological evaluation, all veneer restorations no gingival inflammation, rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession on right maxillary first premolar (14) was mild gingival recession less than 1 mm., rated as score 1. Caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 14,24,25 were placed in 2010. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, one veneer restoration showed debonding at left maxillary second premolar tooth (25). Marginal adaptation, all veneer restorations, which still intact with teeth, rated as score 0. Marginal discoloration rated as score 0 for all veneer

restorations. Both left and right Maxillary first premolar were intact with teeth and fully retained. The biological evaluation, veneer restorations of right maxillary first premolar (24) showed moderate gingival inflammation, rated as score 2. Postoperative hypersensitivity, gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 12,22 were placed in 2010. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation and marginal discoloration of most veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival

inflammation rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.



Ceramic veneer restorations on teeth number 14,13,12,11,33,32,31,41,42,43,44 were placed in 2010. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of

most veneer restorations rated as score 0. While, mesiobuccal margin of left mandibular central incisor (31) rated as score1. Marginal discoloration of all veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation, right maxillary canine (13), left mandibular canine (33) and right mandibular first premolar (44) showed moderate inflammation with bleeding on probing, rates as score 2. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession on right maxillary canine (13) was mild gingival recession, rated as score 1. Caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 15,14,12,11,21,22,24,25 were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The

mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation rated as score 0 all teeth. (No visual evidence of marginal discoloration on the margin.) Marginal discoloration rated as score 0 all teeth. One veneer restoration on left second premolar showed fracture at cervical area rated as score 2 (The restoration is deep crack line/moderate to severe chipping. Replacement is required.). The biological evaluation, left lateral incisor (22) and left maxillary premolar (24) showed moderate gingival inflammation with bleeding on probing rated as score 2. While, others showed no gingival inflammation. No postoperative hypersensitivity and caries rated as score 0. Gingival recession rated as score 1 on left maxillary second premolar (25). (Visual evidence of gingival recession ≤ 1 mm.) Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 13,12,11,21,22,23 were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of most veneer restorations rated as score 0. While, midpalatal margin of left maxillary canine (23) rated as score1. Marginal discoloration of left maxillary canine (23) rated as score1. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation showed gingival inflammation rated as score 0 on left maxillary canine (23). Left maxillary lateral incisor (22) and left maxillary central incisor (21) showed mild gingival inflammation, rated as score1. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 34,33,32,31,41,42,43,44 were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation at midbuccal area of left mandibular canine (33) and right mandibular lateral incisor (42) rated as score 1. Also, midpalatal area of left mandibular lateral incisor (32) and right mandibular lateral incisor (42) rated as score 1. (Slightly discontinuity detectable from

explorer with clinical acceptable). Marginal discoloration of left mandibular canine (33) left mandibular lateral incisor (32) right mandibular lateral incisor (42) at palatal area rated as score 1. (Visual evidence of marginal discoloration from slightly staining, which can be polished away). Most veneer restorations were intact with teeth and fully retained, rated as score 0. One veneer restoration showed mild fracture of veneer at incisal third of left mandibular canine (33), rated as score 1. The biological evaluation, left mandibular lateral incisor (32) and right mandibular central incisor (41) showed mild gingival inflammation, rated as score 1. Gingival recession found on left mandibular canine (33) and right mandibular first premolar (44), rated as score 1. Postoperative hypersensitivity, gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 12,11,21,22 were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation and marginal discoloration of most veneer restorations rated as score 0. Right maxillary lateral incisor had history of fracture. The new veneer restoration was replaced. The biological evaluation showed no gingival inflammation rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as

score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on right lateral incisor (12) were placed in 2011. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, right lateral incisor (12) resulted in no debonding. Marginal adaptation and marginal discoloration of veneer restoration rated as score 0. Veneer restoration was intact with teeth and fully retained. The biological evaluation, veneer restoration showed no gingival inflammation, rated as score 0. Postoperative hypersensitivity, gingival recession and caries rated as score 0. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 14,12,11,21were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation and marginal discoloration rated as score 0 all veneer restorations. All veneer restorations were intact with teeth and fully retained. The biological evaluation, most veneer restorations showed no gingival inflammation. In contrast, right lateral incisor (12) showed moderate gingival inflammation, rated as score 2 (Moderate inflammation: moderate glazing,

redness, edema, and hypertrophy. Bleeding on probing). No veneer restorations showed postoperative hypersensitivity, gingival recession and caries, rated as score 0. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restoration on right maxillary central incisor (11) was placed in 2012. The esthetic evaluation resulted in excellent color matching. The mechanical evaluation, right maxillary central incisor (11) resulted in no debonding. Marginal adaptation and marginal discoloration rated as score 0. Veneer restoration was intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. Veneer restoration had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0.

Ceramic veneer restorations on teeth number 12,11,21,22 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation at midpalatal area of left lateral incisor (22) rated as score 1. (Slightly discontinuity detectable from explorer with clinical acceptable). Marginal discoloration of left lateral incisor (22) at palatal area rated as score 1. (Visual evidence of marginal discoloration from slightly staining, which can be polished away). All veneer restorations were intact with teeth and fully retained. The biological evaluation, veneer restorations showed no gingival

inflammation. However, right maxillary central incisor (11) showed moderate gingival inflammation, rated as score 2. Postoperative hypersensitivity, gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 15,14,13,12,11,21,22,23,24,25, 35,34,33,32,31,41,42,43 ,44,45 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no

debonding. Marginal adaptation of all veneer restorations rated as score 0. Marginal discoloration of all veneer restorations rated as score 0. Most veneer restorations were intact with teeth and fully retained. While right maxillary second premolar (15) showed mild chipping of veneer restoration at incisal one-third, rated as score 1 (The restoration is intact with craze line and /or minor chipping of restoration (1/4 of restoration). This fracture can repair or polishing.) The biological evaluation, right maxillary first premolar (14) showed mild gingival inflammation, rated as score 1(Mild inflammation: slight change in color and little change in texture.). Also, left maxillary lateral incisor (22) showed moderate inflammation, rated as score 2 (Moderate inflammation: moderate glazing, redness, edema, and hypertrophy. Bleeding on probing). Others showed no gingival inflammation. All veneer restorations had history of postoperative hypersensitivity, and later disappeared, rated as score 1(Present symptom of postoperative sensitivity after veneer fixation.). Gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 13,12,11,21,22,23 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of all veneer restorations rated as score 0. Marginal discoloration of all veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained. The biological

evaluation, veneer restorations of both left and right central incisor showed moderate gingival inflammation and bleeding on probing, rated as score 2. Postoperative hypersensitivity, gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 12,11,21,22 were placed in 2012.

The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation and marginal discoloration of most veneer restorations rated as score 0. All veneer restorations were

intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0 of all veneer restorations. One patient had irreversible pulpitis in one tooth (lateral incisor, #12) after veneer placement, rated as score 1. Radiographic photography before veneer placement had no sign of periapical lesion. The lesion was treated with root canal treatment and palatal filling with resin composite, which did not involve with veneer restoration.

Ceramic veneer restoration on right maxillary central incisor (11) was placed in 2012. The esthetic evaluation resulted in excellent color matching. The mechanical evaluation, right maxillary central incisor (11) resulted in no debonding. Marginal adaptation and marginal discoloration rated as score 0. Veneer restoration was intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. Veneer restoration had no history of

postoperative hypersensitivity. Gingival recession and caries rated as score 0. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on right and left maxillary central incisor (11,21) was placed in 2012. The esthetic evaluation resulted in excellent color matching. The mechanical evaluation, right and left maxillary central incisor (11,21) resulted in no debonding. Marginal adaptation and marginal discoloration rated as score 0. Veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. Veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restoration on left maxillary central incisor (21) was placed in 2012. The esthetic evaluation resulted in excellent color matching. The mechanical evaluation, left maxillary central incisor (21) resulted in no debonding. Marginal adaptation and marginal discoloration rated as score 0. Veneer restoration was intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. Veneer restoration had no history of

postoperative hypersensitivity. Gingival recession and caries rated as score 0. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 13,12,11,21,22,23 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation and marginal discoloration of all veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation showed

no gingival inflammation, rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 14,13,12,11,21,22,23,24 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation of most

veneer restorations rated as score 0. Marginal discoloration of all veneer restorations rated as score 0. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation, all veneer restorations showed healthy gingival, rated as score 0. veneer restorations had no history of postoperative hypersensitivity and no gingival recession. Caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

Ceramic veneer restorations on teeth number 12, 22 were placed in 2012. The esthetic evaluation resulted in excellent color matching all teeth. The mechanical evaluation, all teeth resulted in no debonding. Marginal adaptation rated as score 0. Marginal discoloration of right maxillary lateral incisor (12) at palatal area rated as score 1. All veneer restorations were intact with teeth and fully retained, rated as score 0. The biological evaluation showed no gingival inflammation rated as score 0. All veneer restorations had no history of postoperative hypersensitivity. Gingival recession and

caries rated as score 0 of all veneer restorations. Radiographic examination showed no significant finding, rated as score 0.

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