One-year clinical evaluation of IPS Empress CAD versus polished Celtra Duo ceramic Laminate veneers (randomized controlled clinical trial)

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ABSTRACT

Objective: To evaluate fracture resistance and survival rate of IPS Empress CAD versus Polished Celtra Duo ceramic laminate veneers. Material and Methods: Thirty-six ceramic laminate veneers were fabricated for maxillary anterior teeth. The patients were divided into two groups according to the material Group 1 (control group) fabricated from IPS Empress CAD laminate veneers and group 2 (intervention group) fabricated from Polished Celtra Duo laminate veneers. Standardized the same preparation with butt joint design and chamfer finish line located supra gingival were performed for all the teeth. The fabrication of the veneers was performed using Cad.Cam (Ceramill motion) machine, with software (Exocad). The veneers surfaces were treated and silanated according to the manufacture instruction of each ceramic and enamel surfaces were etched where total etch adhesive protocol was obeyed using BISCO. Follow up sessions were done every two months up to one year for each patient using dental probe and operator vision to evaluate the fracture, survival rate, marginal adaptation, sensitivity and caries. according to USPHS criteria (United States Public Health Service). This was performed by an experienced, blinded investigator. Results: Fracture resistance, marginal adaptation, retention, caries and sensitivity were evaluated according to the criteria of USPHS and we found there is no significant difference as both groups scaled zero score. Conclusion: Both IPS Empress Cad and Polished Celtra Duo laminate veneers revealed successful clinical performance in terms of fracture resistance, marginal adaptation, retention, and sensitivity after one year follow up period.

KEYWORDS

Ceramic laminate veneers; IPS Empress CAD; Celtra DUO; Clinical performance.

RESUMO

Objetivo: Avaliar a resistência à fratura e a taxa de sobrevivência de laminados de cerâmica IPS Empress CAD versus Celtra Duo polidos. Material e Métodos: Trinta e seis facetas cerâmicas foram confeccionadas para dentes anteriores superiores. Os pacientes foram dividos em dois grupos de acordo com o material Grupo 1 (grupo controle) confeccionado com laminados IPS Empress CAD e grupo 2 (grupo intervenção) confeccionado com laminados Celtra Duo polidos. A mesma forma de preparo e acabamento de chanfro localizado supra-gengival foram realizados para todos os dentes. A confecção das facetas foi realizada em máquina Cad.Cam (Ceramill motion), com software (Exocad). As superfícies laminadas foram tratadas e silanizadas de acordo com as instruções do fabricante de cada cerâmica e as superfícies de esmalte foram condicionadas seguindo o protocolo adesivo de condicionamento ácido total com BISCO. Sessões de acompanhamento foram realizadas a cada dois meses durante um ano para cada paciente usando sonda exploradora e visão do operador para avaliar a fratura, taxa de sobrevivência, adaptação marginal, sensibilidade e cário; de acordo com os critérios USPHS (Serviço de Saúde Pública dos Estados Unidos). Isso foi realizado por um investigador experiente e cego. Resultados: a resistência à fratura, adaptação marginal, retenção, cário e sensibilidade foram avaliadas de acordo com os critérios da USPHS e não encontramos diferença significativa, pois ambos os grupos escalonaram pontuação zero. Conclusão: As facetas laminadas IPS Empress Cad e Celtra Duo polido revelaram desempenho clínico bem-sucedido em termos de resistência à fratura, adaptação marginal, retenção e sensibilidade após um período de acompanhamento de um ano.

PALAVRAS-CHAVE

Laminados cerâmicos; IPS Empress CAD; Celtra DUO; Desempenho clínico.
INTRODUCTION

Ceramic laminate veneers have become widely a restoration of choice because of their esthetic appeal, biocompatibility and adherence to the concept of minimal invasive dentistry [1].

Long-term success of ceramic laminate veneers could be influenced by several factors, such as type and depth of preparation, type and thickness of the ceramic, type (enamel or dentin) and surface area of the adhesion surface, type of the resin cement and dental adhesive, tooth morphology, as well as functional and parafunctional activities [2].

The most common failure type for laminate veneers was reported to be fractures. The greatest shortcoming of ceramic materials is their low ductility that is an inherent problem yielding to crack formation that can be induced during laboratory and technician adjustments or even during machining especially when used in thin restorations as laminate veneers. Also, polymerization shrinkage of the luting composite may create stress concentrations at the adhesive interface [3-5].

It was found that in case of glass ceramics laminate veneers (feldspathic, leucite based and lithium silicate-based ceramics) fracture of the ceramic is the most frequent reason for failure (44.83%). The second reason for failure was cracks in the ceramic veneer (27.59%). Chipping and debonding occurred in 10% of all failure cases [6].

CELTRA DUO: is a new generation of glass ceramic material enriched with approximately 10% zirconia by weight, which resulting in zirconia reinforced lithium silicate ceramic (ZLS). The material has a special fine grained and homogeneous structure which provides excellent material quality and consistency, higher load capacity as well as long term reliability. Additionally, the material has outstanding processing characteristics, including easy milling and polishing. After the milling process takes place no additional crystallization step required [7]. The flexural strength of the milled restoration is 210 MPa. After glaze firing the flexural strength is increased to 370 MPa [8].

For the patient’s comfort, ceramic restorations should have smooth surface. It is also important for esthetic and biological reasons. So, polishing of ceramic surfaces is mandatory after removal of excess cement or after occlusal adjustments [9].

External marginal adaptation of ceramic veneers, which is defined as "the vertical distance between the finish line of the prepared tooth and the margins of the fabricated veneers" [5] has an important role in the success of any type of restorations[5].

According to Gresnigt et al. [5] who observed decrease in the marginal adaptation of leucite based laminate veneers which recorded after a follow up period of 6 month. More marginal deterioration was observed after 12 months follow up.

CELTRA DUO was introduced to offer a stronger glass ceramic material thanks to its zirconia reinforcement (approx. 10 % by weight) that could undergo phase transformation of the tetragonal phase to the monoclinic phase with a volume increase thus prevents crack propagation which might lead to a better clinical performance in terms of fracture. Also, it has Optimized edge stability compared to leucite-based ceramics that might result in better marginal adaptation, retention and less post-operative sensitivity [8].

The aim of this study was to evaluate the clinical performance of IPS Empress CAD versus Polished Celtra Duo ceramic laminate veneers.

The null hypothesis of this study was that, for anterior teeth requiring conservative labial restoration, veneers constructed using Polished Zirconia reinforced Lithium silicate ceramics (Celtra Duo) compared to IPS Empress CAD ceramics will provide better fracture resistance, marginal integrity and survival rate.

MATERIAL AND METHODS

Ethical considerations and approval

This study was reviewed by the Ethics Committee of Scientific Research - Faculty of Dentistry – Cairo University, Cairo, Egypt and
approved in July 2017 (approval no. 17711). A written informed consent was obtained from all patients who participated in the study under the approval of ethics committee.

Registration
This study was registered on the ClinicalTrials.gov (Identifier: NCT03136276)

Study design
This study was a double blind randomized controlled clinical trial with a 1:1 allocation ratio.

Participants
All patients selected for the study were with an age range between 20 to 30 years old, have no active periodontal or pulpal diseases, have teeth with good restorations. Their chief complaint was to enhance their smile. Information was given to each patient regarding the alternative treatment options. The treatment plan was explained for each patient. Then, they agreed to sign the informed consent before proceeding to clinical work. They were able and willing to maintain good oral hygiene measures. All participants were recruited during the time from September 2017 till November 2018 from the outpatient clinic of Fixed Prosthodontics Department, Faculty of Dentistry, Cairo University, Cairo, Egypt. Screenings of patients were carried out until target number was reached. This study was completed by January 2020. Full medical and dental history were obtained from all participants.

Sample size calculation
Based on previous studies by Beier et al. [6] and Zimmermann et al. [10], a total sample size of 36 laminate veneers (18 in each of the 2 groups) will have 82% power to detect a difference in percentage of fracture of 13.7%; the percentage of fracture when using leucite based porcelain laminate veneers is 17% and 3.3% when using zirconia-reinforced lithium silicate ceramic with a 0.05 two-sided significance level (90% confidence interval). Sample size was calculated using nQuery Advisor.

Allocation concealment
A prosthodontics colleague who was at arm's length from the study was asked to generate the random sequence of participant allocation. This process was completed electronically, using computer-based generation programs. This person prepared sequentially numbered opaque envelopes, each of which contained a card that was marked with the group assignment (A or B) according to the randomly generated sequence. When the recruitment process started and the consenting participant was deemed eligible to participate in the RCT, the next sealed envelope in the sequence was opened and the participant was assigned to the study group indicated on the card.

Implementation
The candidate under supervision was responsible of all procedures, patient selection, preparation, shade selection, try in and bonding.

Allocation
Sequence generation
A prosthodontics colleague allocated the participant patients into two groups with 1:1 allocation ratio by using computerized Sequence generation

Randomization Sequence Generator
Participants were allocating in two different groups with 1:1 allocation ratio by using computerized sequence generation (www.randomizer.org).

Participants were assigned in two groups:
Group (I) control group (n = 18): included patients received IPS Empress Cad laminate veneers with butt preparation design.

Group (II) intervention group (n = 18): included patients received CELTRA DUO laminate veneers with butt preparation design.

Blinding
Double blinding (trial participants and outcome assessor), Prosthodontics colleague assessors who are blinded about the aim of the study and participant's allocation were responsible for assessing the outcomes of this study. The level of intra- and inter-examiner reliability was determined for each assessor by the performance of a calibration session prior to the start of the trial. A training exercise to the assessors with the main investigator helped to standardize measurement
techniques and parameters. An interactive calibration session will enable the investigator to quantitate the measurement variability among and between assessors and enable the optimization of the measurement process. The assistant supervisor (Jylan El Guindy) solved any conflict that may arise between the assessors by repeating the assessing and giving the final opinion.

Pre-operative photographs for each patient were taken using 100 mm usm Canon macro lens mounted on Canon 650D DSLR camera (Canon, Japan) (Figure 1). Two pairs of alginate impressions (Tropicalgin, Zhermack, Italy) for upper and lower arches were taken using stock trays, poured with type IV dental stone (Denflo-HX, Prevest DenPro, India). One pair of impression was used for making diagnostic cast and the other for the study cast. The diagnostic casts were mounted on a semi adjustable articulator to assess horizontal and vertical overlap (overjet and overbite) between maxillary and mandibular incisors in order to preserve the anterior guidance. Following careful analysis of the diagnostic models, minimal veneer preparation was performed for the teeth to be restored with veneers. Diagnostic wax up was fabricated on diagnostic model in order to establish the appropriate tooth proportion, incisal edge positions, correction of minor tooth rotations and measuring the spaces in the hope of creating a more natural appearance.

A putty silicon (ZitaPlus, Zhermack, Italy) was used to obtain index for each patient using condensation silicon impression material. Each index was vertically cut at the mid of central, lateral, and canine of each side to assess the amount of preparation of incisal and labial surfaces respectively. Another putty silicon index was fabricated on the diagnostic wax up model which was used later for temporization.

The labial reduction was started with horizontal orientation grooves using depth cutter wheels (Universal crown and veneer preparation set, Intensiv, Switzerland) in order to accommodate veneers of equal thickness. Final depth of the preparation was marked and accentuated with a pencil. Then the remaining island of the enamel was removed till the depth of original grooves to uniformly reduce the labial surface using a tapered diamond stone with around end of 0.5mm diameter. Labial reduction was 0.3 mm at the cervical third and 0.5 mm at the middle and incisal thirds to ensure even preparation thickness. The preparation was carried out in two different planes following the contour of the labial surface. Then the preparation was verified with the silicon index to check the amount of labial preparation. Vertical orientation grooves were done on the incisal edge of the tooth ensuring not to penetrate more than the diameter of the stone visually. The tapered stone with round end diamond stone was placed parallel to the incisal edge to remove the projection between grooves resulting in 1 mm butt joint incisal preparation. Teeth were finished and smoothed with 1 mm incisal reduction (Butt joint preparation design). Then each preparation was verified vertically with the silicone index to check the amount of incisal reduction. The cervical margin was created supra-gingivally along the free gingival margin. The margin of the preparation was ended by a chamfer finish line 0.5 mm diameter using a tapered diamond stone with a round end. Due to using CAD CAM system in all restorations the interproximal preparation not extended beyond the contact areas except in spacing cases. The preparation was done using a tapered diamond stone with a round end.

All sharp line angles that might serve as a focal point for stress concentration were rounded using tapered round end diamond stone particularly at the junction of the incisal angle to both the labial and proximal surfaces.
Before proceeding with the following steps, a retraction cord was used to allow accurate impression making (Figure 2).

Final impression was taken using addition silicon (Elite HD+, Zhermack, Italy) in stock trays. Two step impression technique was done, first putty viscosity was taken then light viscosity was applied. Application of light using automatic mixing tips and dispensing with impression gun which produced complete homogenous mix.

The silicon index that was fabricated on the waxed-up cast was used for provisional restoration (Structure 2SC, Voco, USA) construction. The patient viewed the results of the provisionals and any modifications were discussed with the operator.

Once the dental laboratory received the final impression, master casts were poured with a type IV dental stone according to manufacturer’s instruction, with respect to water/powder ratio and mixing time. Vacuum mixing was used for proper mixing to ensure the production of void free casts. An extra oral scanner (Ceramill Map 400 Scanner, Amann Girrbach GmbH, Austria) was used to scan the master cast. A three-dimensional image was obtained for each tooth on the computer screen. Using Exocad software (Exocad GmbH, Germany), then the captured pictures were saved in the preparation folder. The software calculated a virtual model from the scanned pictures and an automatic margin finder was used for preparation margin detection. The cement space was set by the software to be 50 microns (Figure 3). Using 5-axis milling machine (Ceramill Motion II, Amann Girrbach GmbH, Austria) the veneers were milled from IPS Empress CAD (Ivoclar Vivadent, Germany) and CELTRA DUO (Dentsply Sirona, Germany) blocks. The milling process started as follows: the type of block (IPS Empress CAD – CELTRA DUO) as well as the size were selected and placed in the spindle of the milling chamber and fastened with set screw. The milling process was completed without any interference with one diamond bur in the shaping process, with copious water sprayed from both directions. After completing the milling process, the veneers were separated manually from the block holder with a diamond cutting instruments.

According to the manufacturer instructions, a universal contouring & polishing kit (Meisinger, USA) was used. A coarse grit finishing instrument was used to prepare the surface for polishing and to create a more uniform surface. Followed by a medium and then a fine wheel was used at (8,000-12,000 rpm) using light to medium pressure.

After veneers have been tried in, they were cleaned with alcohol, rinsed with water and then the following regime for preparing the fitting surface of the veneers was carried out. The fitting surface of the ceramic veneers were etched for 60 seconds in case of IPS Empress veneers and for 30 seconds in case of Celtra Duo veneers using 9.5% hydrofluoric acid. The veneers were rinsed with water for 20 seconds then dried with air by using three-way syringe. Following this protocol, the veneers surfaces appeared clean and had a similar appearance to etched enamel. A single coat of the ceramic primer was then applied to the bonding
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surface of the veneers and left for 1 minute then air dried.

For preparation of tooth for bonding, 37% Phosphoric acid etchant was applied to enamel for 30 seconds. And then rinsed and dried until enamel appeared frosty. Finally, surfaces were dried gently for 5 seconds. A fully saturated brush tip of Single bond 2 (3M ESPE, Germany) was used to apply two coats of adhesive. Luting resin cement (Choice2 light-cured Cements, Bisco, U.S. A) was applied to the tooth and fitting surfaces of the veneers using a mini brush. The veneers were placed to the teeth in position from the midline starting from the midline and moving laterally. Excess cement was removed using sharp explorer after 2 seconds of preliminary light polymerization and the veneers were then completely light polymerized for at least 60 seconds from each aspect of the tooth. A waxed dental floss was used inter dentally for complete removal of excess cement in between veneers, and articulating paper was used to check for any occlusal interferences after complete curing (Figure 4).

![Figure 4 - Postoperative intraoral frontal view.](image)

Patients were instructed to perform brushing and flossing regularly and to use non-abrasive fluoridated tooth paste. They were informed to avoid the excessive stresses, avoid bite on fingernails. The patients returned to the clinic after 1 week to permit a final examination of aesthetics, phonetics and occlusion. Follow up sessions were done every two months for each patient using dental probe and operator vision to evaluate the fracture, survival rate, marginal adaptation, sensitivity and caries. Follow up done according to USPHS grades (United States Public Health Service) (Table I).

### RESULTS

Descriptive statistical analysis presented in (Table II).

**Fracture**

According to USPHS criteria for fracture evaluation:

a) **Group I (IPS Empress):**

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

b) **Group II (Celtra Duo polished):**

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

**Relation between both groups:**

There was no statistically significant difference between (Group I) and (Group II) both groups showed zero scoring in all time periods.

<table>
<thead>
<tr>
<th>outcome name</th>
<th>Measuring device</th>
<th>Measuring Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Fracture</td>
<td>(USPHS)</td>
<td>0 = no fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = minor cracks line over the restoration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = minor chipping of the restoration (1/4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = moderate chipping of the restoration (1/2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 = severe chipping of the restoration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 = complete fracture</td>
</tr>
<tr>
<td>Survival rate</td>
<td>(USPHS)</td>
<td>0 = no sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = slight sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = moderate sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = severe sensitivity</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>(USPHS)</td>
<td>0 = smooth margin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = enamel exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 = base or dentin exposed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = debonding from one end</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 = debonding from both ends</td>
</tr>
<tr>
<td>Marginal adaptation</td>
<td>(USPHS)</td>
<td>0 = no evidence of caries at the margin of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>restoration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = evidence of caries continuous with the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>margin of restoration</td>
</tr>
</tbody>
</table>

| caries (USPHS)       | 0 = no evidence of caries at the margin of restoration |
Survival rate

According to USPHS criteria for survival rate evaluation:

a) Group I (IPS Empress):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

b) Group II (Celtra Duo polished):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

Relation between both groups

There was no statistically significant difference between (Group I) and (Group II) both groups showed zero scoring in all time periods.

Sensitivity

According to USPHS criteria for sensitivity evaluation:

a) Group I (IPS Empress):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

b) Group II (Celtra Duo polished):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

Table I - Descriptive statistical analysis of the outcomes

<table>
<thead>
<tr>
<th>Modified USPHS criteria</th>
<th>Base line</th>
<th>After 2 months</th>
<th>After 4 months</th>
<th>After 6 months</th>
<th>After 8 months</th>
<th>After 10 months</th>
<th>After 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture</td>
<td>Empress (n=18)</td>
<td>0 18 18 18 18 18 18 18 18 18 18 18 18 18 18</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>Survival rate</td>
<td>Empress (n=18)</td>
<td>0 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Empress (n=18)</td>
<td>0 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>Marginal adaptation</td>
<td>Empress (n=18)</td>
<td>0 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>Caries</td>
<td>Empress (n=18)</td>
<td>0 18 18 18 18 18 18 18 18 18 18 18 18 18 18 18</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

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difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero score was recorded for all the veneers at all the intervals of evaluation.

Relation between both groups

There was no statistically significant difference between (Group I) and (Group II) both groups showed zero scoring in all time periods.

Marginal adaptation

According to USPHS criteria for marginal adaptation evaluation:

a) Group I (IPS Empress):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero grade was recorded for all the veneers at all the intervals of evaluation.

b) Group II (Celtra Duo polished):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero grade was recorded for all the veneers at all the intervals of evaluation.

Relation between both groups

There was no statistically significant difference between (Group I) and (Group II) both groups showed (100%) Zero grading in all time periods.

Caries

According to USPHS criteria for caries evaluation:

a) Group I (IPS Empress):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero grade was recorded for all the veneers at all the intervals of evaluation.

b) Group II (Celtra Duo polished):

There was no statistically significant difference between (Base line), (After 2 months), (After 4 months), (After 6 months), (After 8 months), (After 10 months) and (After 12 months) where (p=1).

Zero grade was recorded for all the veneers at all the intervals of evaluation.

Relation between both groups

There was no statistically significant difference between (Group I) and (Group II) both groups showed (100%) Zero grading in all time periods.

DISCUSSION

For clinically successful dental restorations, four distinct properties should be existing: marginal adaptation, biocompatibility, esthetics and mechanical strength [11].

In the present study all teeth included were anterior teeth. It was restricted to non-carious, unrestored teeth which prevented the size and sites of disease or restorations from influencing the preparations carried out.

In the present study preparation design for all teeth was with chamfer finish line labially, interproximal extension and butt joint incisally. The finish line was located supragingivally [12,13].

Hahn et al. [14] reported that butt-joint preparation showed better stress distribution
to the tooth body, suggesting that the forces had to be sustained to a greater extent by the veneer itself. Butt joint incisal configuration still permits the preservation of peripheral enamel layer around all margins. This was in agreement with Mirra et al. [15] who measured fracture strength and microleakage of laminate veneers with different designs and found the highest fracture load in teeth prepared with 2 mm incisal reduction without palatal chamfer.

In this study ceramic laminate veneers were fabricated from two different ceramics materials: IPS Empress CAD is a leucite glass-ceramic of the SiO$_2$-Al$_2$O$_3$-K$_2$O material systems with leucite crystal ranging from 5 to 10 µm in size. The leucite crystals responsible for increasing the material strength and inhibition of crack propagation, while the crystalline phase absorbs the fracture energy. Resistance and flexural strength of the material is improved due to the difference in the coefficient of thermal expansion between the glass phase and the crystalline phase, as well as the cooling process following sintering phase (160 Mpa) [7].

CELTRA DUO: is a new generation of glass ceramic material enriched with approximately 10% zirconia by weight, which resulting in zirconia reinforced lithium silicate ceramic (ZLS). The material has a special fine grained and homogeneous structure which provides excellent material quality and consistency, higher load capacity as well as long term reliability. Additionally, the material has outstanding processing characteristics, including easy milling and polishing. After the milling process takes place no additional crystallization step required [7]. The flexural strength of the milled restoration is 210 MPa. After glaze firing the flexural strength is increased to 370 MPa [8].

Fracture results

The most common failure type for laminate veneers was reported to be fractures. Different factors are responsible for crack development in all-ceramic restorations of all forms. The greatest shortcoming of ceramic materials is their low ductility that is inherent problem yielding to crack formation. Also, polymerization shrinkage of the luting resin cements may create stress concentrations at the adhesive interface. In-vivo strength degradation of restorations based on dental ceramics may occur in oral environment as a consequence of masticatory and parafunctional forces more than 200 N [3,4,5,6].

Flaws of different magnitudes may be introduced to the restorations depending on the chewed food and associated mastication force. In addition, damage may occur during the adjustments of ceramic restorations by the technician or the clinician prior to or during their placement in the mouth [16].

In this study, Zero score was recorded for all veneers during all the follow-up sessions. Additionally, there was no statistically significant difference between the two groups. It was found by Mirra et al [15] that butt joint design with 2 mm incisal preparation presented the highest fracture resistance and least microleakage of laminate veneers with different designs.

Also, zirconia-reinforced lithium silicate ceramic is a glass ceramic material enriched with a zirconium dioxide content around ten times that of traditional CAD/CAM glass ceramic. Zirconia is known for phase transformation of the tetragonal phase to the monoclinic phase with a volume increase that prevents crack propagation [17] in combination with a particularly fine-grained and homogeneous structure leads to a high fracture strength of 370 MPa [18, 19, 20].

The results of this study were in agreement with Osman et al [21] who evaluated the clinical performance of VITA Suprinity versus IPS E-Max CAD ceramic laminate veneers where both groups showed 100% Alpha score after 1 year
follow up.

**Survival rate results**

Zero score of retention was recorded for all veneers. Etching the ceramic surface with 9.5% HF increased the surface area and facilitated the penetration and retention of resin cement into the microretentions of the treated surface. The bonding process can be enhanced by application of silane coupling agent. These agents are capable of forming chemical bonds between the inorganic phase of the ceramic and the organic phase of the resin that will increase bonding strength to ceramic laminate veneers itself thus improve the durability of the adhesive interface overtime [22, 23].

**Post-operative sensitivity results**

The result of this clinical study showed that in both material post-operative sensitivity was graded Zero during all follow up session graded. Additionally, there is no significant difference between the two materials. This may be related to the extension of preparation which mainly in enamel in our study. This was in agreement with Öztürk et al [2] who show that postoperative sensitivity when preparation done in enamel or enamel with minimal dentin evaluation was Alpha during two years follow up.

This also conducted with Karagözüoğlu et al [22] when they found that laminate veneers have 100% successes in post-operative sensitivity after 2 years follow up.

**Marginal adaptation results**

Taskonak et al. [24] examined the “perfect margin” and defined it as two adjoining surfaces (cement–ceramic, cement–tooth), which have no interruption of the continuous margin and merge into each other without any difference in level. The “perfect margins” can be analyzed by measuring the marginal gaps.

Marginal fit is considered one of the most important criteria in the evaluation of fixed dental prostheses and is one of the most significant prerequisites for the long-term success of ceramic restorations. The large the marginal discrepancy results in the high plaque index with subsequent gingival inflammation and more the exposure of luting material to the oral environment. Furthermore, if the cement seal fails, it allows bacterial percolation, secondary caries, pulpal inflammation, and eventually pulpal necrosis could result [25].

Some studies have reported that the ideal marginal gap should be 25 to 50 μm for cemented restorations. Other studies considered the marginal gap values of 100-150 μm to be clinically acceptable for cemented restorations. Recent studies have considered the clinically acceptable values of marginal gap to be less than 100 μm [26].

Measurement of marginal discrepancy should be consistent, reproducible, and standardized. There are many methods for measuring marginal discrepancy includes: (1) direct view, (2) tactile and visual examination which was conducted in this study [26, 27].

Good adaptation has been found to be critical for the longevity of restoration. In the literature the clinically acceptable size of marginal gap varies. For CAD/CAM fabricated restorations, the values reported in the literature before cementation range from 50 to 60 μm. Guess et al. [28] reported that CAD/CAM manufactured restorations exhibited significantly larger internal fit values than the press groups. While Aboushelib et al [29] reported that pressable ceramic laminate veneers produced higher marginal adaptation, homogenous and thinner cement film thickness, and improved resistance to microleakage compared to machinable ceramic veneers.

Placement of restoration margins 1 mm supra-gingival within enamel, may explain the absence of marginal deterioration in these
areas. It is well known that the adhesive bond in enamel is more durable than that in dentine [28]. In this study the extension of preparation was mainly in enamel.

The results obtained in the present study as zero score for marginal adaptation were attributed to the butt-joint incisal configuration and preservation of a peripheral enamel layer around all margins, also, this design established an easy path of insertion of the laminate during bonding [30]. Najim et al. [31] found that the CAD/CAM veneers with butt joint incisal reduction produced the most accurate margins while the least favorable combination was the pressable ceramic veneers with overlapped incisal reduction.

In addition, resin cement used effectively reduces microleakage. This may be attributed to formation of a hybrid layer with excellent quality at the dentine, ensuring adhesion and resistance to various stresses [18]. In 2009 Aykor et al. [32] found that using total-etch system for bonding ceramic laminate veneers resulted in successful marginal adaptation and detection of no secondary caries. This is due to the fact that the boundaries of the veneer preparation were left within enamel in all cases.

Caries results

The result of this clinical study showed that in both material secondary caries was graded Zero during all follow up sessions. Additionally, there is no significant difference between the two materials. This was in agreement with Guess et al [28], D’arcangelo et al. [33] who showed that secondary caries when preparation done in enamel evaluation was Alpha during follow up period.

Finally, the hypothesis was rejected as both materials were graded Zero during all follow up sessions and no significance difference found between the two materials (IPS Empress CAD - Celtra Duo).

The limitation of this study was the short follow up period where the clinical outcomes of laminate veneers could be adversely affected with longer follow up time. Further studies with longer follow up period and larger number of participants is suggested.

CONCLUSION

Within limitations of this study, the following conclusion could be drawn as follows:

Both IPS Empress Cad and Polished Celtra Duo laminate veneers revealed accepted successful clinical performance in terms of fracture resistance, marginal adaptation, retention, and sensitivity after one year follow up.

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Conflict of interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subject's oversight committee guidelines and policies of: the Ethics Committee of Scientific Research - Faculty of Dentistry – Cairo University. The approval code for this study is: 17711.
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One-year clinical evaluation of IPS Empress CAD versus polished Celtra Duo ceramic Laminate veneers (randomized controlled clinical trial)

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