

## Clinical Evaluation Of The Aesthetic And The Translucency Properties For Porcelain Laminate Veneers Fabricated Using Heat-Pressed And CAD/CAM Techniques

Research Article

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### Abstract

**Background and Aim of Study:** porcelain laminate veneers have become a very common cosmetic choice due to their highly aesthetic properties in addition to their long-term clinical survival, and considering the various methods of manufacturing the porcelain laminate veneers it has left the practitioner facing a difficulty when it comes to choosing the best technique there is for manufacturing veneer, thus the aim of this study is to evaluate the esthetic properties and the translucency of porcelain laminate veneers that are fabricated with the heat-pressed and the CAD/CAM techniques.

**Materials and Methods:** The study sample consisted of (60) IPS e.max porcelain laminate veneers (N=60) that have been done on 7 patients and it was divided into two equal groups (n1=n2=30). In the first group, Porcelain laminate veneers were fabricated using CAD/CAM technique (IPS e.max CAD), and the second group, Porcelain Laminate veneers were fabricated using Heat-Pressed technique (IPS e.max Press), whereas they were cemented using light cured resin cement (Variolink N). the esthetic properties were evaluated according to World Dental Federation (FDI) criterions ( surface shine, surface staining, esthetic anatomical form) after one week- 3 – 6 – 12 months of the cementation. data analysis was done using Mann-Whitney U test and using Fisher's exact test for correlated samples for studying the significance of statistical differences at significance level (0.05= $\alpha$ ).

**Results:** the results of the evaluation of surface staining and esthetic anatomical form in both of the study groups were clinically accepted, whereas there were no statistically significant differences during all the follow-up periods, while the surface shine and translucency in the (IPS e.max CAD) group were less with a statistically significant difference than the (IPS e.max Press).

**Conclusions:** within the limits of this study we conclude that (IPS e.max CAD) porcelain laminate veneers have a lesser degree of surface shine and translucency properties than (IPS e.max Press) porcelain laminate veneers. In addition to that, there was no detected effect on the esthetic criterion (surface staining and esthetic anatomical form) when using different fabrication methods of porcelain laminate veneers.

### Introduction

For several years, Porcelain crowns and porcelain laminate veneers have been a common option for treating simple cases of crowded upper anterior teeth of which it affects the aesthetic appearance, Nevertheless, full porcelain crowns are considered not conservative [1, 2]. This has led to putting into consideration porcelain laminate veneers as a preferable esthetical and functional treatment option for such cases as it is more conservative and it leads to a more aesthetic results [3]. Porcelain laminate veneers were first introduced as the first aesthetic treatment option in the early year of 1980 AD [4].

Reaching excellent aesthetic results using porcelain laminate veneers is known to have its difficulties for dentists, this is due to the complicated visual properties of the different shades of natural teeth, it requires a good knowledge of the basic principles and the visual properties of the restoration materials in order to reach successful aesthetic restorations [5], in addition, the process itself of manufacturing porcelain restorations with shades as close as possible to natural teeth shades is considered a true challenge in dentistry [6].

For several years, feldspathic ceramic have been considered one of the best materials to be used in fabricating porcelain laminate veneers due to the advanced aesthetic properties of it [7], nev-

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ertheless, the constant updates and developments that were applied on the porcelain materials, the glass ceramic reinforced with lithium disilicate crystals (IPS e.max) have now become the best option to be used in fabricating veneers because of its' bending resistance properties in addition to the excellent aesthetic properties [8].

Porcelain laminate veneers with glass ceramic base (IPS e.max) are fabricated using either the Heat-Pressed technique which come in an ingots form that are later pressed after melting the wax model using the conventional lost wax technique, then the ceramic ingots are fused and pressed under a controlled heat and press, using computer programmed press ovens (IPS e.max Press), or the porcelain laminate veneers are fabricated using computer aided design and manufacturing (CAD/CAM) which they come in a blocks form that are partially crystalized and mechanically carved, this process doesn't take more than a few taps on the keyboard in order to design and manufacture a highly accurate restoration (IPS e.max CAD)[10, 11].

There are many factors affecting the shade of dental restorations such as: fabricating technique, baking process, glazing, liquid to powder ratio, oral cavity environment circumstances, and aging [12, 13].

Several studies have evaluated the aesthetic properties of porcelain laminate veneers fabricated using feldspathic ceramic [14, 15], nevertheless, there was a lack of information regarding the evaluation of the aesthetic and translucency properties of porcelain laminate veneers with a glass ceramic base (IPS e.max) fabricated using Heat-pressed technique and (CAD/CAM) technique, therefore, the main subject of this study was considered to be the clinical evaluation of the aesthetic and translucency properties of porcelain laminate veneers fabricated using Heat-pressed technique and computer aided design and manufacturing (CAD/CAM).

## Materials And Methods

The study sample consisted of 60 IPS e.max porcelain laminate veneers divided into two groups:

First group: consisted of 30 IPS e.max porcelain laminate veneers fabricated using computer aided design and manufacture technique CAD/CAM.

Second group: consisted of 30 IPS e.max porcelain laminate veneers fabricated using Heat-Pressed technique.

The veneers were applied on 7 regular visitors to the fixed prosthodontics department in Damascus University Faculty of Dentistry who suffer from aesthetic problems in their teeth appearances, the age range was between 21 and 49 years old.

The admission criteria were that the patient age must be between 18 and 50 years old, and the patient must have an obvious indication for porcelain laminate veneers (teeth shape and size modification, slightly stained teeth, simple cases of diastema, simple cases of teeth crowding or tilted teeth, simple fractures, enamel defects or having poorly applied dental restorations), in addition to that, the gingiva and the periodontal tissues must be in a healthy condition, there must be a normal anterior occlusion bite, good oral

hygiene and the patient approval to participate in follow up tests. The demission criteria consisted of having big previous restorations, teeth suffering from extended fractures, endodontic treated teeth, the loss of inferior teeth support and patients who suffer from high caries rate.

First, the main complaint and patient history were taken and the realization of the expected aesthetic result was created in mind and the form which was created for the sake of this scientific study was filled by each patient, the form contained information that relates to the purpose of this study, information about general and medical history of the patient plus the patients' written approval, in addition, extra oral and intra oral examination were performed and intra oral pictures and pictures of the smiling status were taken.

Teeth were prepared to receive porcelain laminate veneers using the bevel incisal preparation, margins were finished using smooth conical bur after putting in the gingival retraction cords in order to reach an accurate and precise finishing line [16] (Fig.1).

Final impression was taken using additional silicone and the opposite arch impression was taken using alginate, in addition to the wax bite of the prepared teeth.

Following steps include choosing a suitable shade using teeth shade guide and having the patients' approval and document that shade, temporary prosthesis were made using intra oral acrylic.

Regarding the porcelain laminate veneers fabricated using computer aided design and manufacture CAD/CAM technique, at the beginning, a powder spray was applied on the surface of the prepared teeth cast model dies for scanning purposes, a laser digital scanning process was performed using a 3D camera connected to the device (CCD), utilizing the designing program (3D inLab) a 3D picture of the cast model was obtained on the computer screen which is also connected to the laser scanner device.

Finishing lines of the preparation were defined on the digital hypothetical cast leaving a hypothetical space for the luting cement around 40 micron, and then the anatomical modifications were made on the porcelain laminate veneers using special features of the designing program (Fig.2).

After finishing the designing process, the IPS e.max CAD block (which has the right shade and translucency for each case) is placed tightly in its' alleged place in the carving device InLab MC LX, when the carving order is given the process starts under cooling with cold water (Fig.3).

When the chamber lights turn green it means that the carving process has ended successfully and it's time to open the chamber lid and take out the carved block.

Each veneer is then separated from the remaining section of the Block using specific separating disks, whereas the porcelain laminate veneers is now unhardened completely and have a blue color shade (Fig.4).

The porcelain laminate veneers are placed in a hardening oven (Programt P500) in order for the crystallization to begin, with heating degree up to 840-850 C for 15 minutes, the hardening and

the crystallization processes are considered to be easy and cause no following shrinkages [17].

The inner structure of the porcelain laminate veneers gain its' solidness and its' shade when the hardening process is over, after that, veneers are covered with glass ceramic which contains Fluor apatite crystals (IPS e.maxceram) in order to have the desired high aesthetic result, the final step is glazing.

Before final cementation, provisional prostheses are removed and porcelain laminate veneers are placed to evaluate proper fitting of the restorations in addition to the evaluation of a pleasing shade, after taking the patients' approval of the aesthetic outcome of the porcelain laminate veneers, final cementation of the veneers is performed, intaglio surfaces are etched using hydrofluoric acid (Ultradent) with 9% concentration for 90 seconds according to the manufacturing company instructions, then washed with running water and dried with airflow, double bonding agent is applied (MonoBond S) for 60 seconds, spreaded using a slight airflow only.

Regarding prepared abutments, for isolated working area mouth opener was applied in addition to cotton roles and saliva suction,

prepared surfaces were etched using phosphoric acid with 37% concentration for 30 seconds, washed with flowing water and dried with airflow till the chalky appearance was obvious.

Dentin bonding agent (Tetric-N Bond) was applied on prepared surfaces then spreaded using a slight airflow only, resin light cured cement (Variolink N) is then applied on the intaglio surface of the porcelain laminate veneers and properly spreaded on the whole inner surface, porcelain laminate veneer are then placed on the right abutments for each one, accurate fitting was evaluated through direct site and marginal adaptation.

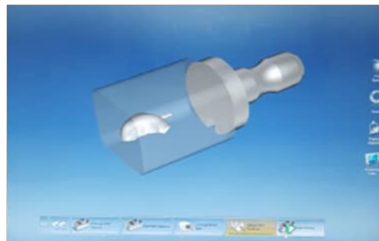
Resin cement was light cured from the buccel and the palatal approach for 3-4 seconds only to have the cement at its' pasty phase, this was done to ease removing the excess cement using dental probe and surgical blade type 12, excess cement in the proximal areas was removed using dental floss.

Then, resin cement was light cured from abuccel, palatal and incisal approach for 60 seconds per each, margins were finished using extremely soft diamond finishing burs, and soft abrasive strips for the proximal areas (Fig. 5).

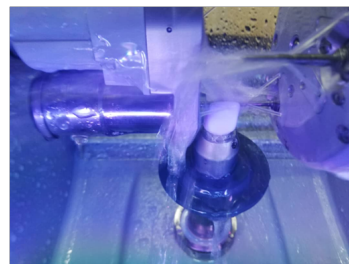
**Figure 1. Preparation finishing and gingival retraction.**



**Figure 2. Computer-aided design (CAD) for veneer.**



**Figure 3. Computer-aided manufacturing (CAM) for veneer.**



**Figure 4. Porcelain laminate veneers before fully crystallization.**



Figure 5. Porcelain laminate veneers after cementation.



Table 1. FDI Criteria for the evaluation of the PLV.

| criterion           | Score                                     |  |  |   |  |
|---------------------|---|--|--|---|--|
|                     | 1   | 2  | 3  | 4   | 5  |
|                     | Clinically excellent/ very good           | Clinically good  | Clinically sufficient/ satisfactory  | Clinically unsatisfactory   | Clinically poor  |
| 1. Surface luster   | Surface luster is close to enamel luster. | Surface is slightly dull but isn't notable from speaking distance. | Surface is dull but is considered acceptable when covered with saliva.                                   | Surface is rough and cannot be camouflaged by saliva, must be modified.               | Surface is extremely rough and replacement is needed.  |
| 2. Anatomical form  | Anatomical form is ideal.                 | Anatomical form is slightly different from the natural form.       | Anatomical form is different from the natural form but is aesthetically acceptable.                      | Anatomical form is aesthetically unacceptable, correction and modification is needed. | Anatomical form isn't acceptable at all and the PLV must be replaced.                                      |
| 3. Surface staining | No surface staining is observed.          | Simple staining is observed, can easily be fixed by polishing.     | Moderate staining is observed, might appear on other teeth and is considered aesthetically unacceptable. | Unacceptable surface staining is observed, interference is needed in order to fix it. | Extreme surface staining is present, might be under the veneer, interference in this case is not possible. |

FDI Criteria)Hickel et al., 2010).

Table 2. Questions asked by residents and answered with yes or no for evaluation translucency, esthetic appearance and shade.

| Question number | Question  | Answer                    |
|-----------------|---|---------------------------|
| 1               | was there any notable difference in the translucency between the PLVs?        | <input type="radio"/> Yes |
|                 |   | <input type="radio"/> No  |
| 2               | was there any notable difference in the esthetic appearance between the PLVs? | <input type="radio"/> Yes |
|                 |   | <input type="radio"/> No  |
| 3               | was there any notable difference in the shade between the PLVs?               | <input type="radio"/> Yes |
|                 |   | <input type="radio"/> No  |

Table 3. The Mann–Whitney U test to study the difference in surface luster for both study groups (n= 60).

| Evaluation time | group           | ranks mean | U-value | P-value | significance             |
|-----------------|-----------------|------------|---------|---------|--------------------------|
| After one week  | IPS e.max CAD   | 31         | 435     | 317     | No differences           |
|                 | IPS e.max Press | 30         |         |         |                          |
| After 3 months  | IPS e.max CAD   | 33         | 375     | 21      | Statistical differences. |
|                 | IPS e.max Press | 28         |         |         |                          |
| After 6 months  | IPS e.max CAD   | 33         | 375     | 21      | Statistical differences. |
|                 | IPS e.max Press | 28         |         |         |                          |
| After 12 months | IPS e.max CAD   | 33         | 375     | 21      | Statistical differences. |
|                 | IPS e.max Press | 28         |         |         |                          |

IPS e.max CAD: Porcelain laminate veneers fabricated by CAD/CAM technique.  
IPS e.max Press: Porcelain laminate veneers fabricated by Heat-Pressed technique.

Table 4. Frequencies and percentages of the translucency differences between study groups.

| Translucency differences  | IPS e.max CAD |      | IPS e.max Press |      |
|---------------------------|---------------|------|-----------------|------|
|                           | Frequency     | %    | Frequency       | %    |
| No differences detected   | 20            | 67%  | 30              | 100% |
| Differences were detected | 10            | 33%  | 0               | 0%   |
| Total                     | 30            | 100% | 30              | 100% |

The required data of each case were registered in the form of each patient during the permanent cementation visit, these clinical cases had then follow up visits a week, 3 months, 6 months, and 12 months after cementation, the cases were evaluated by two practitioners independent from the researcher without informing them with the fabricating techniques used for the porcelain laminate veneers, the practitioners were taught how to perform the evaluation, a third practitioner was required when having a disagreement on a certain point of the evaluation.

First, surface luster and roughness were evaluated by visually comparing them with natural luster and roughness of the enamel of the adjacent teeth, the process was performed without the dental chair light source. Numbers were given to each observed case according to Hickel (2010) [18] listed in the following Table (1).

Surface staining of the porcelain laminate veneers was visually evaluated by comparing with the adjacent teeth surfaces. Numbers were given to each observed case according to Hickel (2010) listed in the following Table (1).

Anatomical form of the PLV was evaluated by noticing its' effect on the general aesthetic appearance. Numbers were given to each observed case according to Hickel (2010) listed in the following Table (1).

Finally, the residents were asked questions with a Yes or No answer for evaluation translucency, esthetic appearance and shade listed in the following Table (2).

## Results

Seven patients participated, and a total of 61 PLVs were evaluated in this study.

Study sample consisted of 60 IPS e.max PLVs divided into two equal groups:

Surface luster in all of the PLVs at both study groups (IPS e.max CAD, IPS e.max Press) was close to natural enamel luster, except for one PLV in the IPS .max CAD group after one week (3%), and 5 other PLVs in the same group after 3, 6, and 12 months of follow up, the surface of these veneers was slightly dull but isn't notable from speaking distance.

There were no statistically significance difference between the two groups after one week of follow up ( $p=0.317$ ), whereas the PLVs of the IPS e.max CAD group presented less surface luster than the IPS e.max heat-Pressed group after 3, 6, and 12 months of follow up with a statistically significant difference ( $p= 0.021$ ) Table (3).

No surface staining cases were detected in both study groups (IPS e.max CAD, IPS e.max Press) during all of the follow up sessions (after one week, 3, 6, and 12 months).

Aesthetic anatomical form was ideal in the IPS e.max CAD group during all of the follow up periods, whereas the aesthetic anatomical form was slightly different from the natural appearance in 7% of the PLVs in the IPS e.max Press group, nevertheless, all of the other PLVs in this study group had ideal aesthetic anatomical form during follow ups.

33% of the PLVs (IPS e.max CAD) group had differences in translucency, whereas no differences were found in the PLVs (IPS e.max Press) group during follow ups Table (4).

Chi-squared test was used to study translucency differences between study groups during follow ups. Translucency differences values of the CAD/CAM group were greater by 33% than the values of the Heat-Pressed group with a statistically significant difference ( $p> 0.0005$ ).

There were no aesthetical nor color differences in the PLVs between the two study groups.

## Discussion

PLVs fabrication techniques have varied throughout the years, originally they were made using the layering technique, nevertheless, this technique required a lot of time and effort in order to make an accurate fit of the restoration on the prepared tooth [19]. New generations have presented new porcelain materials to Dentistry that used Heat-Pressed technique, whereas this technique also required great time and effort due to the process of waxing, melting, molding, carving, and heat-pressing and it needs a highly skilled technician to carve the aesthetic anatomical details and to insure good inner and marginal fit [20, 21], but with the rapid evolution of the digital computer technology and the new generations of porcelain materials that are now presented in blocks form capable of being carved, this has led to the usage of computer aided design and manufacturing systems (CAD/CAM) in fabricating PLVs, which don't require more than a few taps on the keyboard to design and manufacture a highly adapted restoration, therefore reducing time and effort comparing to previous techniques [22].

Glass ceramic reinforced with lithium disilicate crystals system was adopted (IPS e.max) in this study due to it being clinically accepted and has better mechanical properties than the traditional feldisbaric ceramic, in addition to its' high aesthetic and translucency qualities without affecting the hardness and durability of the PLV [7].

Functional properties were evaluated using World Dental Federation (FDI) criterias considering these criterias to be flexible, easy, practical, and unified, plus they are more accurate and more sensitive to detecting differences in restorations [24, 25].

The surface of PLVs fabricated using (CAD/CAM) technique had less luster than the surface of PLVs fabricated using Heat-Press technique after 3, 6, and 12 months of follow ups, after investigating the cause of this very slight roughness, it appeared to be due to wrong teeth brushing techniques performed by these patients, this minor roughness was especially detected in the PLVs that are cemented on the premolars which they receive excessive brushing force compered to anterior PLVs which are on the incisors [26].

The results of this study agreed with the results of a study made in 2020 by Souza et al where they noticed that onlays (IPS e.max CAD) had slight roughness according to FDI criterias, and it was due to the removal of the glazing layer during occlusion modifications after cementing the restoration [27].

No surface staining was detected in both study groups during follow ups, this was due to patients not having acidic foods and drinks with excessive amounts and not having a history of illnesses causing acidic oral environment such as chronic vomiting, in addition to the process of manufacturing the ingots and blocks of the glass ceramic containing of lithium disilicate crystals that is performed ideally in a way that prevents pores creation, which blocks the absorption of oral fluids and pigments [17, 28].

Aesthetic anatomical form of the PLVs was ideal in both study groups except two veneers that were slightly different form the natural appearance (grade 2 of the FDI criterias), but there was no statistically significant difference between the study groups, the reason might be due to the usage of covering porcelain (IPS e.maxceram) on the cores of the PLVs in both study groups, which is considered having high visual, aesthetic, and translucency properties.

PLVs fabricated using CAD/CAM technique had less translucency than PLVs fabricated using Heat-Pressed technique despite of the color matching, the reason might be because of the crystallization process is partial at the beginning in the PLVs fabricated using CAD/CAM technique, whereas the coloring elements experience an oxidation state at this phase, the PLVs are blue or grayish blue at this point and after the full crystallization has ended they gain the required color and translucency [29], in addition to that, there might be another reason which is due to the different microbial structure of each porcelain type, IPS e.max Press has crystals size range from 3 to 6 microns, whereas IPS e.max CAD has crystals size range from 0.8 to 1.5 microns, because of the same crystals percent in both porcelain types, the porcelain that has larger crystals, they tend to be less in number and density therefore higher translucency [10].

This study results agreed with the results of a study made by Tuncdemir et al which reported that PLVs fabricated using CAD/CAM technique had greater color changes than PLVs fabricated using Heat-Pressed technique, this was due to lack of accurate marginal adaptation which leads to micro leakage, in addition to using dual-cured resin in the cementation of PLVs [30].

## Conclusions

Within the limits of this study, the following was concluded: PLVs fabricated using CAD/CAM technique had less luster and translucency than PLVs fabricated using Heat-Press technique. No differences were detected between the two fabricating techniques of the PLVs regarding: surface staining and aesthetic anatomical form.

## Recommendations

Glass ceramic reinforced with lithium desilicate crystals (IPS e.max) is recommended in fabricating PLVs because of the high mechanical, translucency, and aesthetical properties.

IPS e.max Press is recommended In cases that require high aesthetic appearance because of its' high luster and translucency properties.

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