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One-year clinical evaluation of e.max CAD and LavaTM ultimate laminate veneers with butt joint preparation (Randomized controlled clinical trial)

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Abstract

Purpose: The aim of this clinical study was to evaluate ceramic laminate veneers constructed from Lithium disilicate (IPS e.max CAD), and resin nano-ceramic (Lava Ultimate™ CAD/CAM) according to the modified United States of Public Health Service (USPHS) criteria over 12 months.

Materials and methods: Twenty-eight ceramic laminate veneers (fourteen for each group) were placed in the Fixed Prosthodontics Department clinics, Faculty of Dentistry, Cairo University by one operator. The restorations were made using CEREC premium 4.4 CAD/CAM software with IPS e.max CAD and Lava Ultimate™ CAD/CAM blocks. Modified USPHS criteria were used to evaluate the clinical performance of the restorations. Patient satisfaction were assessed using visual analogue scale. Fisher's Exact test was used to compare between the two groups. Friedman's test was used to study the changes by time in each group. Patient satisfaction scores (VAS scores) were presented as median and range values.

Results: Regrading marginal adaptation, retention, and fracture, through the whole study period; all restorations in the two groups showed **(Alpha)** scores. While for marginal discoloration, all surfaces of restorations in the two groups showed **(Alpha)** scores till 6 months. While after 8, 10 and 12 months; the palatal surface of Lava Ultimate group showed **(Bravo)** scores. However, there was no statistically significant difference between the two groups after 12 months (*P*-value = 0.481). The overall satisfaction of restorations was very satisfied by 85.7% and satisfied by 14.3%.

Conclusion: Both IPS e.max CAD and Lava Ultimate laminate veneers revealed high successful clinical performance over a period of 12 months follow up.

Introduction

The treatment of defective and discolored anterior dentitions has always created a challenge in dentistry. Ceramic laminate veneers offer a conservative esthetic treatment, which met patient expectations for many years [1].

Various common techniques to fabricate porcelain veneers include the platinum foil or refractory die technique, in which porcelain in powder form is stacked on top of a refractory die and then fired in the oven. Another method is the pressing ceramic technique involving waxing up the restoration to the proper form and pressing it under pressure into the evacuated mold, similar to the lost wax technique for metal. The most advanced technique uses the Computer-aided Designing/Computer-aided Manufacturing "CAD/ CAM" system [2].

Two main types of materials are currently available for esthetic CAD/CAM-processed indirect dental restorations: glass-ceramics and hybrid resin ceramics [3].

The use of IPS e.max CAD is well documented in the literatures having successful restoration modality, due to its superior optical and mechanical properties. The introduction of hybrid ceramic materials combined the advantages of both glass ceramics and composite resin. Resin nano-ceramic is a mixture of a resin composite matrix and nano-ceramic fillers of approximately 80% by weight [4].

In a direct comparison between properties, glass-ceramic materials are superior to resin-composites. The attractiveness of the latter is based on ease of fabrication and the possibility of an easier and more feasible intra-oral repair of minor defects induced by function [3].

Therefore, combination of both material properties in one material resulted in characteristic superior properties [3].

Dentists should base their choice of material on the requirements of the tooth being restored, such as the indication and the necessity of the tooth preparation to improve esthetics and function.

Clinical studies for comparative evaluation of both CAD/CAM glass ceramic and hybrid ceramic laminate veneers is absent in the literature and more attention should be drawn to clinical comparison of both materials.

Hypothesis of this study that there will be no difference in the clinical performance of Lava Ultimate if compared to IPS e.max CAD ceramic laminate veneers for restoration of teeth in esthetic zone.

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Materials and methods

The ceramic laminate veneers included in the study were completed by one operator (the researcher) and one experienced dental technician. The patients were randomly divided into 2 equal groups (fourteen laminate veneers for each group) using random sequence generator from the website (www.random.org).

The investigators and the statistician were blind throughout the whole procedures and follow-up visits.

Their chief complaint was to enhance their smile. The treatment plan was explained for each patient. Then, they agreed to sign the informed consent before proceeding to clinical work.

Patients selected were characterized as follows:

1. From 18-50 years old, be able to read and sign the informed consent document.

2. Be physically and psychologically able to tolerate conventional restorative procedures and have no active periodontal or pulpal diseases, have teeth with good restorations.

Scaling and polishing were performed for each patient and shade of the teeth was recorded visually using vita 3D master shade guide under natural day light between 10 am and 12 noon on days with a clear sky.

Preliminary impressions were made to obtain study casts. Following a careful analysis of the models, diagnostic wax-up was fabricated in order to establish the appropriated mock up for the patients.

Preparation

The labial reduction was started with horizontal orientation grooves in two different planes using depth cutter wheel within range of 0.3-0.5 mm at the cervical third and 0.6-0.8 mm at the middle and incisal thirds to ensure that the whole preparation remained within the enamel. The preparation was ended labially by a chamfer finish line 0.5mm diameter equigingivally using a tapered diamond stone with rounded end. Vertical orientation grooves were done on the incisal edge of the teeth using tapered diamond stone of 2mm diameter resulting in 2 mm butt joint incisal preparation. Then preparation was verified with the silicon index to check the amount of incisal and labial reduction.

Final impression

Putty/light two-step impression was made using addition elastomeric silicon impression material (Express™ VPS Impression Material, 3M ESPE, St. Paul, MN, USA) using stock tray.

Provisional restoration

Silicon index obtained from the waxed up cast was used to construct provisional restoration. It was filled with temporary crown material (Protemp™ II 3M ESPE, St. Paul, MN, USA) and placed on the teeth that were spot etched and bonded.

Veneer fabrication

An intra-oral scanner (CEREC Omnicam, Sirona Dental CAD/CAM System, GmbH) was used to scan both master and opposing casts to obtain a virtual model on the computer screen. CEREC premium 4.4 CAD/CAM software was used to prepare the best suitable design for the laminate veneers and the different tools were used to customize each veneer to the final desired shape. The final restorations were tested before their milling by CAD/CAM wax milled with the final shape of the final restorations.

IPS e.max CAD veneers were fired in a firing cycle in a ceramic furnace. Lava Ultimate laminates were polished after milling with fine rubber tool and polishing agent until the luster surface appeared.

Cementation procedures

Pre-treatment of lava ultimate veneers

Lava Ultimate veneers were cleaned in an ultrasonic cleaner and gently air blowed. Then, air abraded following the manufacturer instructions to obtain matt surface. The adhesive (Scotchbond™ Universal Adhesive, 3M ESPE, St. Paul, MN, USA) was applied to the bonding surface of the veneer and left for 60 seconds to react.

Pre-Treatment of IPS e.max CAD veneers

IPS e.max CAD veneers were cleaned with alcohol, rinsed with water and air dried for preparing their fitting surface to be etched for 20 seconds with 9% hydrofluoric acid (Porcelain Etchant 9%, BISCO, USA).The veneers were rinsed with water and dried with air. A single coat of the ceramic primer (Bisco Porcelain Prime/Bis-Silane, BISCO, USA) was then applied to the bonding surface of the veneers and left for 1 minute to react then dried with air.

37% Phosphoric acid etchant was applied to enamel for 15 seconds. Then rinsed and dried resulted in frosty enamel appearance. Two coats of adhesive were applied to the teeth surface. The veneers were cemented in place with light cured veneer resin cement (RelyX™ Veneer Cement | 3M ESPE, St. Paul, MN, USA) using an energy density of 480 mW\cm for 40 seconds from each aspect of the tooth. Preoperative and postoperative photographs are shown in figure 1.

Clinical evaluation

The restorations were visually inspected according to the modified United States Public Health Service (USPHS) criteria with dental mirror and explorer under magnification of dental loupes (*Univet 3.5x, Italy)*. Digital photographs were taken after placement of the veneers of both groups and during follow-up sessions through the whole study period. During the follow up period, no attrition was recorded (Table 1).

Patient satisfaction was evaluated using questionnaire that is shown in figure 2. The questionnaire was carried out by visual analogue scale (VAS).

Results

Qualitative data were presented as frequencies and percentages. Fisher's Exact test was used to compare between the two groups. Friedman's test was used to study the changes by time in each group. Patient satisfaction scores (VAS scores) were presented as median and range values. Mann-Whitney U test was used to compare between the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

Marginal adaptation, retention and fracture

Through the whole study period; all restorations in the two groups showed **(Alpha)** scores.

Figure 1. Preoperative and postoperative lava ultimate veneers close up smile view

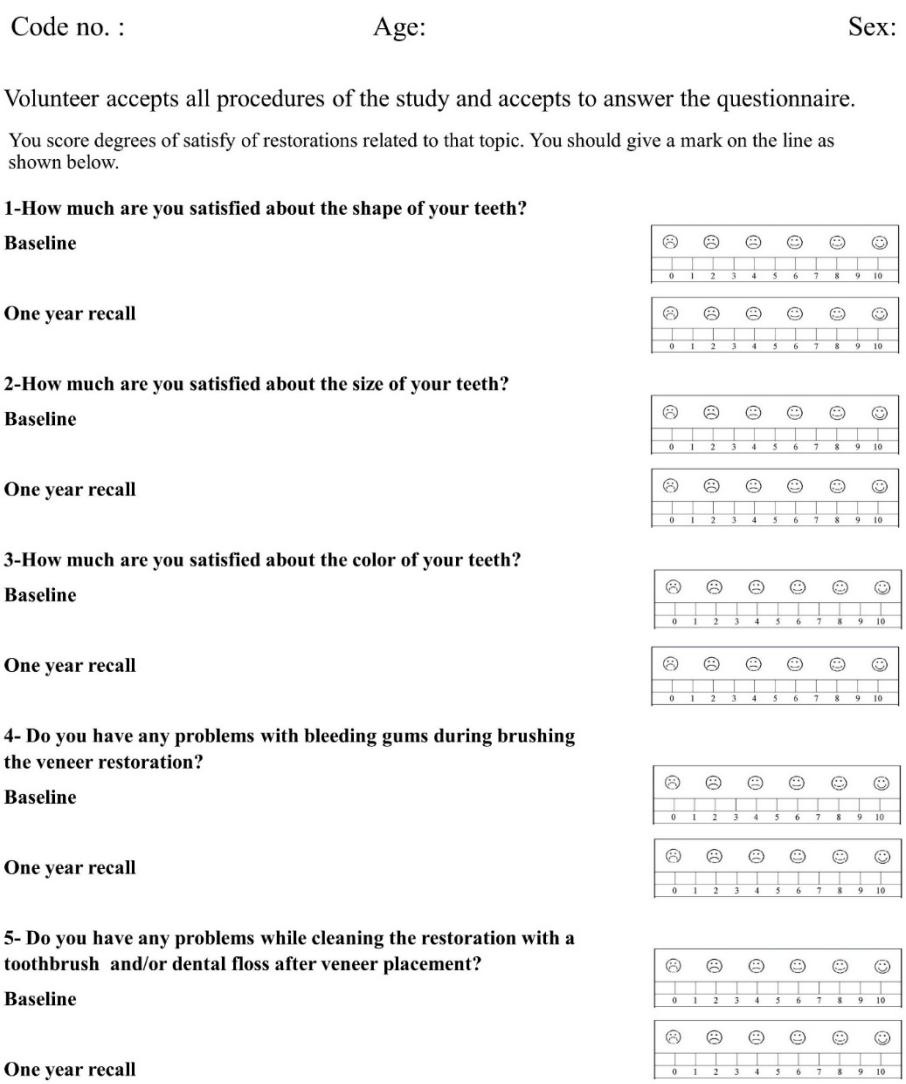

Figure 2. List of the questionnaire for patient satisfaction

Table 1. List of modified United States Public Health Service criteria used for the clinical evaluations of the restorations

Marginal adaptation	**A. (Alpha) Smooth margin** **B. (Beta) Minor voids/defects at margin (probe catch)** **C. (Charlie) Obvious crevice at margin (probe penetrate)**
Fracture of restoration	A. **No fracture** B. **Minor chipping of restoration (1/4 of restoration)** C. **Moderate chipping of restoration (1/2 of restoration)** D. **Severe chipping of restoration (3/4 of restoration)**
Retention	A. **Retained** **B. Debonded**
Marginal discoloration	A. **No discoloration** B. **Slight staining can be polished away** C. **Obvious staining cannot be polished away** D. **Gross staining**

Where: A: Alpha B: Bravo C: Charlie D: Delta
Alpha and Bravo: satisfactory; Charlie and Delta: unsatisfactory except for retention where Alpha is satisfactory and Bravo is unsatisfactory.

Marginal discoloration

All surfaces of restorations in the two groups showed **(Alpha)** scores till 6 months. While after 8, 10 and 12 months; the Palatal surface of Lava Ultimate group showed **(Bravo)** scores. After 8 months, there was no statistically significant difference between the two groups (*P*-value = 0.481, Effect size = 0.277). After 10 and 12 months, there was also no statistically significant difference between the two groups (*P*-value = 0.098, Effect size = 0.408) table 2.

Results of the changes by time within Lava Ultimate group are presented in table 3. There was a statistically significant change in marginal discoloration by time (*P*- value = 0.002, Effect size = 0.494). After 8 months, there was an increase in prevalence of (Bravo) score. After 10 and 12 months, further increase in (Bravo) scores was observed.

Patient satisfaction:

It was divided into esthetical satisfaction evaluation consisted of shape, size, and color satisfaction. In addition, Biological satisfaction consisted of gingival bleeding and flossing problems. The overall satisfaction of restorations was Very satisfied 85.7% and Satisfied 14.3%

At base line as well as after 12 months; Lava Ultimate showed statistically significantly higher median shape and lower median color

Table 2. Descriptive statistics and results of Fisher's Exact test for comparison between marginal discoloration at the Palatal surfaces of the two groups after 8, 10 and 12 months

Time	Lava Ultimate (n = 14)		IPS e.max CAD (n = 14)		*P*-value	*Effect size (Cramer's V)*
	n	%	n	%		
8 months					**0.481**	**0.277**
Alpha	**12**	**85.7**	**14**	**100**		
Bravo	**2**	**14.3**	**0**	**0**		
10 months					**0.098**	**0.408**
Alpha	**10**	**71.4**	**14**	**100**		
Bravo	**4**	**28.6**	**0**	**0**		
12 months					**0.098**	**0.408**
Alpha	**10**	**71.4**	**14**	**100**		
Bravo	**4**	**28.6**	**0**	**0**		

**: Significant at P ≤ 0.05*

Table 3. Descriptive statistics and results of Friedman's test for comparison between marginal discoloration at different follow up periods within Lava Ultimate group

Time	Lava Ultimate (n = 14)	
	N	%
Base line		
Alpha	**14**	**100**
Bravo	**0**	**0**
2 months		
Alpha	**14**	**100**
Bravo	**0**	**0**
4 months		
Alpha	**14**	**100**
Bravo	**0**	**0**
6 months		
Alpha	**14**	**100**
Bravo	**0**	**0**
8 months		
Alpha	**12**	**85.7**
Bravo	**2**	**14.3**
10 months		
Alpha	**10**	**71.4**
Bravo	**4**	**28.6**
12 months		
Alpha	**10**	**71.4**
Bravo	**4**	**28.6**
P-value	**0.002***	
Effect size (w)	**0.494**	

**: Significant at P ≤ 0.05*

Table 4. The median, range values and results of Mann-Whitney U test for comparison between patient 5satisfaction (VAS scores) in the two groups

Time	Item	Lava Ultimate			IPS e.max CAD			*P*-value	*Effect size (r)*
		Median	**Min.**	**Max.**	**Median**	**Min.**	**Max.**		
Base line	Shape	10	9	10	9	9	10	0.026*	0.421
	Size	10	10	10	10	10	10	1.000	0.000
	Color	9	9	10	10	9	10	0.026*	0.421
	Gingival bleeding	10	10	10	10	10	10	1.000	0.000
	Flossing	10	10	10	10	10	10	1.000	0.000
12 months	Shape	10	9	10	9	9	10	0.026*	0.421
	Size	10	10	10	10	10	10	1.000	0.000
	Color	9	9	10	10	9	10	0.026*	0.421
	Gingival bleeding	10	10	10	10	7	10	0.056	0.509
	Flossing	10	10	10	10	10	10	1.000	0.000

**: Significant at P ≤ 0.05*

scores than e.max. There was no statistically significant difference between size, gingival bleeding and flossing scores in the two groups table 4.

Discussion

In comparison to full coverage crowns, ceramic laminate veneers are minimal invasive treatment method in restorative dentistry and can be used to correct tooth form, position and color [5].

The outcomes recorded (marginal adaptation, biocompatibility, esthetics and mechanical strength) are considered distinct properties for evaluating the clinical success of dental restoration [6].

Conventional and current popular practice for conservative laminate veneers preparation on the facial surface, the reduction ranged from 0.3 to 0.8 mm and on the incisal edge from 1.5 to 2 mm that was suggested by many studies [7,8].

In the present study, preparation design for all teeth was butt-joint that was followed by many other authors who reported that butt-joint preparation showed better stress distribution to the tooth body and highest fracture resistance compared with the other techniques [9,10].

In the present study, Lava Ultimate CAD/CAM veneers were sandblasted with aluminum oxide grain size ≤ 50 μm at two bars (30 psi) for 15 sec to increase the surface roughness and result in an irregular surface with some fillers exposure. But Yoshihara et al, 2017 [11] stated that sandblasting also resulted in damaging the composite CAD/CAM block surface as it produce surface and subsurface cracks.

Therefore, sandblasting for CAD/CAM resin blocks must be mild by adjusting both grain size and time as suggested by Tekçe et al. 2018 [12] not to exceed 30 seconds of sandblasting for CAD/CAM resin restoratives as by increasing sandblasting time, surface roughness increased, however, μTBS values decreased and stability of adhesion of CAD/CAM composite restoratives would be disturbed.

In the present study, Scotchbond™ Universal Adhesive containing silane coupling agent was applied to the bonding surface of the Lava Ultimate veneers and scrubbed them for 20 seconds then left for 60 seconds to react that was in consistent with Capa et al. 2018 [13] who proved that following sandblasting, chemical adhesion using a universal adhesive containing silane was effective surface pre-treatment methods for resin nano ceramic CAD/CAM.

The clinical evaluation parameters in this study were following the modified USPHS (Modified United States Public Health Service Criteria). Most studies had followed the modified USPHS/Ryge Criteria for direct clinical evaluation of restoration due to its simplicity to evaluate the clinical veneers and analyze the results enabling the assessment of multiple parameters and provide reliable information regarding the overall long-term success of the restorations [14].

Marginal adaptation

The results obtained in the present study as alpha score for marginal adaptation may be attributed to the butt-joint incisal configuration and preservation of a peripheral enamel layer around all margins, this design established an easy path of insertion of the laminate during bonding [15]. Our results were similar to other authors who found that the CAD/C/AM veneers with butt joint incisal reduction produced the most accurate margins with gap < 100μm in the cervical, middle, and incisal thirds. While the least favorable combination was the pressable ceramic veneers with overlapped incisal reduction [16]. In addition, resin cement used might be effectively reduced the micro-leakage [17]. Following total-etch system for bonding ceramic laminate veneers might be also a reason for successful marginal adaptation and detection of no secondary caries [18].

Fracture

In this study, alpha score was recorded for all veneers during all the follow-up sessions that run similar to other studies [19].

Retention

The alpha score of retained/debonding was recorded for all veneers of both groups. All the teeth was prepared and finished with margins located within enamel, which explained the results of this study that was in agreement with Ozturk et al. 2014 [20] who showed that porcelain veneers partially bonded to dentin, had an increased risk of failure.

Marginal discoloration:

Labially, all the veneers scored Alpha for all the follow up periods which can be attributed to many reasons: (1) All margins are in cleansable areas often easily finished and polished at the time of cementation [21], (2) the glazed surface of IPS e.max CAD [22], and properly finished and polished surface of Lava Ultimate which is mostly impervious to extrinsic stains [23], that protects the underlying light-cured (more color stable) resin cement [24]; and (3) well-fitted restorations and a thin viscosity, but highly filled, resin cement have been used [25].

Palatally, four Lava Ultimate veneers scored Bravo after 12 months follow up period where marginal staining were mainly observed at the incisal edges only from the lingual aspect. Since in these regions, function play a significant role compared to labial surfaces, aging of the adhesive resin or the luting cement, cement washout or initial polymerization shrinkage may be responsible from such deteriorations and eventually staining [26].

The clinical outcome showed marginal discoloration in 14.3% and 28.6% of all the restorations and Lava Ultimate restorations respectively. This result is comparable to other studies that found marginal discoloration in 21.3% of restorations [5] but it is considered higher percentage than Monaraks and Leevailoj 2018 [14] who showed low rate of marginal discoloration (0.6%), found in the veneer restoration of a maxillary central incisor at the palatal site.

The statistical significant change in marginal discoloration of the Lava Ultimate group by time was considered clinically acceptable as they went unnoticed by the patients and once detected it could be easily repolished. Such findings require longer follow up period to assess whether repolishing of the discoloration would still be effective.

Patient satisfaction

In the majority of the clinical studies on this type of restorations, the degree of patient satisfaction has been a factor taken into account. Although Lava Ultimate showed statistically significantly higher median shape and lower median color scores than IPS e.max CAD for patient satisfaction, it was considered clinically insignificant as the patients rated their shape and color satisfaction as 'very satisfied' with score ranging from 9 to 10. The percentage of laminates for the two groups, which reported being 'very satisfied' with score (8-10) and 'satisfied' with score (7) were 85.7% and 14.3% respectively. Our study revealed results that were very similar to those found by other authors. [5,6,14] Patient satisfaction was encouraging, even in patients who recorded low scores.

The hypothesis of this study was accepted since the descriptive data of the two groups in terms of retention, marginal adaptation and

fracture showed no difference (Alpha score). In addition, the difference between the two groups in marginal discoloration was not statistically significant. Although the recorded scores of patient satisfaction were statistically significant between the two groups regarding 'shape' and 'color', they reported no clinical significant difference.

Conclusion

Within the limitations of this study, it can be concluded that both IPS e.max CAD and Lava Ultimate laminate veneers revealed high successful clinical performance in terms of marginal adaptation, fracture, retention, marginal discoloration and patient satisfaction. It can be recommended to implement further randomized clinical studies to evaluate the clinical survival rate of the Lava™ Ultimate laminate veneers over a more prolonged follow up periods.

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