



COMPARATIVE EVALUATION OF MARGIN ADAPTABILITY OF CAD/CAM, IPS E-MAX IPS EMPRESS CROWNS - AN IN VITRO STUDY

Dental Science

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ABSTRACT

OBJECTIVES:

1. To compare the marginal fit of CAD/CAM with IPS e-max
2. To compare the marginal fit of CAD/CAM with IPS EMPRESS
3. To compare marginal fit of IPS e-max with IPS EMPRESS

MATERIALS AND METHOD: A typhodont tooth is taken in this study and is embedded in the self cure acrylic block. Preparation of the tooth done with the basic requirements and 30 impressions made using custom tray, and cast poured. These 30 cast divided into three groups as follows, Group I – 10 Cerec CAD/CAM, Group II – 10 IPS e-max, Group III – 10 IPS EMPRESS. Crowns were fabricated and seated over the master model to check fitness clinically and adjusted if needed. After checking clinically the crowns were cemented to the master model and measurement of the margin is done using Video Measuring System. Six readings were taken for each sample. One way ANOVA and Tukey HSD statistical analysis were done to determine the results.

RESULTS: This study showed that the marginal adaptability of three different all ceramic is within the clinical limits.

CONCLUSIONS: Within the limitation of this study the following conclusions were drawn

- Mean value in Group I (51.1 ± 24.2) is significantly lower than Group III (134.7 ± 46.1) ($P < 0.0001$).
- Mean value in Group II (74.1 ± 26.6) is significantly lower than Group III (134.7 ± 46.1) ($P = 0.001$).
- However, there is no significant difference in mean values between Group I and Group II ($P = 0.30$)

KEYWORDS

All Ceramic, Marginal Adaptability, Cad/cam, Ips E-max, Ips Empress.

INTRODUCTION

The use of all ceramic restorations has gained rapid momentum in the last few years, as has the introduction of the systems aiding the manufacturing of all ceramic restorations.^[1] The development of tooth colored restorative materials was aimed to develop aesthetic replacement of missing tooth structure that will meet the functional mechanical and biological requirements of the oral cavity.

IPS e.max is a modern and innovative system which covers the entire spectrum of all-ceramic indications ranging from thin veneers to 10-unit bridges to maximize the functional requirements of these materials, Ivoclar Vivadent, Inc. has introduced IPS e.max lithium disilicate glass ceramic, a material that provides optimum esthetics, yet has the strength to enable conventional or adhesive cementation.

IPS-Empress 2 (Ivoclar-Vivadent, Schaan, Liechtenstein) was introduced in 1998. Sorensen et al. described this type of ceramic as having a lithium-disilicate crystal content of 60% by volume that forms an interlocking structure after pressing which increases the strength and fracture toughness of the ceramic. This serves as the underlying framework of the restoration.

The presence of marginal discrepancies in the restoration exposes the luting agent to the oral environment and may lead to increased dissolution of the cementing medium, recurrent caries and loosening of the cast restoration.^[2] In vivo studies have provided evidence that a large marginal discrepancy in a fixed restoration correlates with increased plaque retention and reduced gingival health as indicated by higher plaque index, elevated gingival index and increased pocket depth.^[3] Misfits in all-ceramic crowns can also affect fracture strength.^[4] Many factors affect the marginal adaptation of a crown such as the preparation dimensions, type of finish line, type and cement viscosity, location of cement application, physico-chemical interactions between cement, tooth structure and coping, moisture, temperature, relief of the internal crown surface, marginal design of

coping, crown type and seating force.^[5]

The aim of this in vitro study is to evaluate the marginal discrepancy of CAD/CAM, IPS EMPRESS, IPS e-max crowns.

THE OBJECTIVES OF THIS STUDY WAS

1. To compare the marginal fit of CAD/CAM with IPS e-max
2. To compare the marginal fit of with CAD/CAM with IPS EMPRESS
3. To compare marginal fit of IPS e-max with IPS EMPRESS

MATERIAL AND METHOD

PREPARATION OF THE MODEL

A one cubic inch hollow die is taken and self cure acrylic resin (DPI RR cold cure Morman India) is mixed and poured into the die and the typhodont tooth (maxillary left first premolar 24, Kavo, Germany) is embedded until the cemento-enamel junction. Seating grooves are made in the acrylic block and a notch is made for fabrication and reorientation of the special tray. A 1mm spacer is given and 30 special trays were prepared using self cure acrylic resin. They were mounted with the long axes perpendicular [Figure 1].

A preoperative putty index was made ready before preparation using aquasil soft putty (Dentsply, USA) [Figure 2]. A medium-grained and then a fine-grained diamond bur with a 4-degree taper were used to achieve an 8-degree convergence angle. A fine-grained diamond bur with a diameter of 1 mm was used to modify the depth of the shoulder, with the finish lines located 0.5 mm coronal to the cemento-enamel junction; a 1.0-mm-width 90-degree shoulder. All sharp angles were rounded. With an occlusal reduction of 2 mm. Putty index is used to check the uniform reduction.

IMPRESSION AND GROUPING

A relief groove is given in the special tray for escape of excess impression material. A one-stage impression was made for prepared

tooth with a aquasil light body polyether impression material using a custom impression tray [Figure 3]. The light body material was mixed and filled inside the custom tray and kept over the model, and a pressure of 200 psi using a loading machine[Figure 4]. In this manner 30 impressions were made and master dies were poured with die stone . These 30 casts were divided into three groups with 10 in each group.[Figure 5]

- Group I- CAD/CAM (10)
- Group II- IPS e-max (10)
- Group III- IPS EMPRESS (10)

CROWN FABRICATION

Group I models were scanned and milled using CEREC CAD/CAM. One specimen from group II and III was taken and die hardener and die spacer is applied for the wax pattern preparation for all ceramic restoration according to the requirements. After preparation of the wax copings putty index is made which should seat on the grooves and notches of the specimen. The dies of group II and Group III were then applied with die hardener and die spacer and wax copings were prepared using the putty index. The group II wax copings were invested and fabrication of 10 IPS e max crowns done under manufacturers instructions, Group II wax copings were invested and IPS EMPRESS Crowns were done under manufactures instruction.

MEASURING MARGINAL GAP

After fabrication of crowns they are seated over the typhodont model and checked for the fit visually and adjusted if needed. Before cementation, the inner surfaces of the all-ceramic crowns were carefully sandblasted with 50- μ m aluminum oxide at 1.5 bars pressure and subsequently steam-heat cleaned. The prepared teeth were cleaned, rinsed, and gently dried with an oil-free clean airflow. Each crown was seated over the master model with finger pressure and then kept under a static pressure of 40 N for 7 minutes in a loading apparatus with a plastic head. The excess cement was carefully removed. Evaluation of the marginal adaptability is done using video measuring system [Figure 6] . In which 6 points are marked (three points in buccal and three points in palatal) and measured for thirty crowns. After measurement the mean for each crown using six readings are done, and thirty values 10 for each group will be obtained.

STATISTICAL ANALYSIS:

The three groups were statistically analyzed using One Way ANOVA was used to calculate the P-value and Tukey – HSD procedure was employed to identify the significant groups at 5% level.

1. Mean and Standard Deviation were estimated for each study group.
2. Mean values were compared between different study groups by using One way ANOVA followed by Tukey – HSD procedure.
3. In the present study, $p < 0.05$ was considered as the level of significance.

ONE-WAY ANOVA

The formula used is

$$F = \frac{[\sum_{i=1}^k N_i (\bar{X}_i - \bar{X})^2] / (k-1)}{[\sum_{i=1}^k (N_i - 1) S_i^2] / (N - k)}$$

$$\text{where } S_i^2 = (\sum_{j=1}^{n_i} (X_{ij} - \bar{X}_i)^2) / (N_i - 1)$$

ij X is the j^{th} observation in the i^{th} group;

$i\bar{X}$ is the mean of observations in the i^{th} group;

iN is the number of observations in the i^{th} group;

$\bar{X}$ is the overall mean of the entire observations.

TUKEY'S HONESTLY SIGNIFICANT DIFFERENCE PROCEDURE

The formula used is

$$SEYqBA_s / (-=)$$

where AY is the larger of the two means being compared,

BY is the smaller of the two means being compared, and

SE is the standard error of the data in question.

RESULTS

The following results were obtained from this study which compared the marginal adaptability of different all ceramic crowns, CAD/CAM,

IPS e max , IPS EMPRESS . Each group had 10 samples and 6 reading were made for each sample was done.[table 1]

- Mean value in Group I (51.1 ± 24.2) is significantly lower than Group III (134.7 ± 46.1) ($P < 0.0001$).
- Mean value in Group II (74.1 ± 26.6) is significantly lower than Group III (134.7 ± 46.1) ($P = 0.001$).
- However, there is no significant difference in mean values between Group I and Group II ($P = 0.30$) [chart 1]

CHART NO.1.

MEAN VALUES IN DIFFERENT STUDY GROUPS

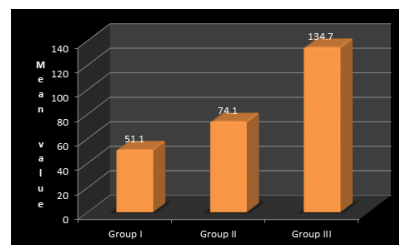


TABLE I COMPARISON OF MEAN OF THREE GROUPS

Group	Mean $\pm$ S.D.	Overall P-value**	Significant Groups\$
I	51.1 $\pm$ 24.2	<0.0001 (Significant)	I vs. III [p<0.0001] II vs. III [p=0.001] {I vs. II [p=0.30 -N.S.]}
II	74.1 $\pm$ 26.6		
III	134.7 $\pm$ 46.1		

**One Way ANOVA was used to calculate the P-value.

\$ Tukey – HSD procedure was employed to identify the significant groups at 5% level.

DISCUSSION

The marginal accuracy is an important criterion in quality of fixed prosthodontics. The marginal fit of different all-ceramic crowns has been studied, but the results show great variation within crown systems.^[6,7,8]

Generally, evaluation of the margin discrepancy of crowns depends on several factors. The use of all ceramic restorations has gained rapid momentum in the last few years, as has the introduction of the systems aiding the manufacturing of all ceramic restorations. The development of tooth colored restorative materials was aimed to develop aesthetic replacement of missing tooth structure that will meet the functional mechanical and biological requirements of the oral cavity

Boening *et al*^[9] evaluated various systems of all-ceramic crowns with regard to accuracy of fit. In vitro studies on machined all-ceramic crowns (Celay) revealed mean marginal gap widths of 25 μ m. Marginal openings were between 20 and 50 μ m in sintered (Cerestore) and cast (Dicor) ceramic crowns. In a study by Chan *et al*^[10], means of largest marginal openings were 158 μ m (Cerestore) and 177 μ m (collarlessporcelain-fused-to-metal crowns). In vitro studies of the fit of Procera AllCeram crowns revealed mean marginal openings below 63 μ m and means of 74 μ m of occlusal adaptation. Other investigators found marginal discrepancies of 83 μ m.

Gu XH^[11] has demonstrated that the marginal discrepancies have proven to be responsible for plaque accumulation, which is the primary causative factor in the etiology of periodontal disease and caries. In addition, poor marginal adaptation is the main cause of frequently encountered esthetic problems. Therefore, independent of the materials used, improvements in the marginal adaptation of restorations are of major clinical significance. Others claimed that marginal discrepancies exceeding 100 μ m are clinically inadequate. The marginal discrepancies of the all-ceramic crowns cemented with three luting agents were all significantly smaller than those of the metal-ceramic crowns. This result is mainly attributed to the excellent adaptation properties of the Empress 2 all-ceramic system. Luting agents may influence the marginal discrepancies through crown elevation after cementation because of differences in viscosity and seating techniques. However, studies by Fleming GJP^{[2][12]} showed that

such influence varies, and in the current study, no significant difference was found among the luting agents.

Leinfelder et al^[13] found interfacial gap should not exceed 100µm. Margins greater than this commonly result in extensive wear of luting cement. According Gassino G et al^{[15][14]} the precision of the eight custom-made crowns and that of the six experimental specimens differed. The mean precision of the experimental crowns varied from 10 to 46 µm, while that of the custom-made ones varied from 35 to 98 µm. Nakamura T et al^{[13][15]} studied the effect of the occlusal convergence angle of the abutment and the computer's luting space setting on the marginal and internal fit of Cerec 3 CAD/CAM all-ceramic crowns and found that the mean marginal gap ranged from 53 to 162 µm. Denissen H^{[5][6]} has found the mean marginal gaps for the CICERO, CEREC, and Procera cores on the stone dies were 74 µm (SD 15), 85 µm (SD 40), and 68 µm (SD 53), respectively. May KB^{[4][7]} evaluated the fit at the crown-die interface for premolar and molar crowns was 56 ± 21 µm and 63 ± 13 µm, respectively. Fleming GJP^{[22][18]} has done a in vitro study on procera and empress crowns and found that the marginal gap of 26- 548µm.

Empress crowns are formed by a process known as hot pressing and uses liquid-state-sintering and the aid of outside pressure and high temperature to sinter objects to full theoretical density. The advantages of this method compared with solid-state-sintering are the elimination of the need for very fine particles and the removal of large pores caused by non-uniform mixing. The high glass content of Empress ingots (approximately 63%) result, in a material that can be melted and injected under pressure into a mould.

CONCLUSION:

The present in-vitro study was done to evaluate the marginal discrepancy of all ceramic crowns - IPS EMPRESS crowns, e-max crowns, and CAD/CAM crowns. The objectives of this study was to compare the marginal fit of CAD/CAM with IPS e-max, to compare the marginal fit of with CAD/CAM with IPS EMPRESS, to compare marginal fit of IPS e-max with IPS EMPRESS. Mean value in Group I (51.1 ± 24.2) is significantly lower than Group III (134.7 ± 46.1) ($P < 0.0001$). Mean value in Group II (74.1 ± 26.6) is significantly lower than Group III (134.7 ± 46.1) ($P = 0.001$). However, there is no significant difference in mean values between Group I and Group II ($P = 0.30$). The marginal discrepancy of Cerec CAD/CAM, IPS e-max, IPS EMPRESS, crowns are under clinically acceptable limits

LIST OF FIGURES:

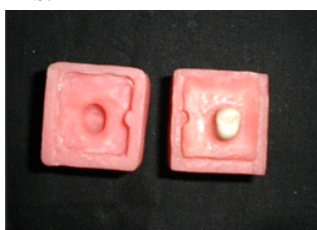


Fig 1: Embedded typhodont tooth and special tray



Fig 2: Indexing before preparation



Fig 3: Impression of prepared tooth



Fig 4: Pressure applied during impression



Fig 5: Prepared CAD CAM, IPS emax, IPS EMPRESS crowns

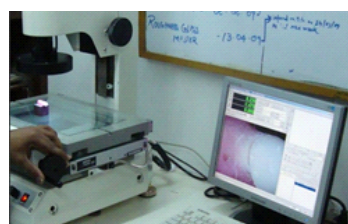


Fig 6: Measuring the marginal fit using video measuring system

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