Effect of Different Die Materials on the Marginal Fit of CAD/ CAM crowns pre and pos -cementation

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Abstract

Theobjective of this in vitro study was to evaluate the vertical marginalgap pre and post-cementation ofIPS e.Max CAD crowns constructed using different die materials.

Materials and method: Thethirty standard aluminum dies were fabricated to receive a full contour IPS e.Max CAD crowns.An impression with two-stage putty-wash impression with spacer technique was taken.The thirty impressions were distributed into three groups;as follows; Group (A) Ten impressions were poured with type IV die stone,Group (B)Ten impressions were poured with type V die stone and Group (C)Tenimpressions were poured with Exacto-form model resin die material.Each die was scanned and IPS e.Max CAD full contour crown was fabricatedusing Sirona CEREC in-Lab CAD/CAM System. Sixteen gap measurements were taken for each sample (Buccal, Mesial, Lingual and Distal), Pre and post-cementation process were measured using a digital microscope.The results of this study showed that there were statistically highly significant differences ($P<0.01$) between three different die materials groups of pre and post-cementation procedure**.**From the results of this study,it could be concluded that the Exacto-form provided the least vertical gap, when used IPS e.Max CAD full contour restorations. Die stone type V could be the next choice, which is preferred over to die stone type IV.cementation step incressed the marginal gapsiginficatly

Keywords: *Die Materials, IPS e.max CAD, CAD/CAM , Pre and Post- Cementation Procedure,MarginalFit.*

Introduction

To obtain accurate and precise models with no distortion, it is important to acquire accurate impressions and to use stable and precise die materials. Die material is one of the factors affecting the accuracy of the replica[1]Type IV, type V gypsum (die stone) and polyurethane resin (Exatofrom) were widely used to pour the impressions.The properties of gypsumincludes high strength, low expansion easy to use, and allowing easy separation of the working cast from the impression. Polyurethane resin (Exakto-form)has been also used as die material for its accurate reproduction and maximum edge stability, extremely high fluidity of this resin allow pouring of impression with high precision and without the formation of bubbles[2].

Material and Method

A dentoform maxillary right first molar tooth (Dentoform, Nissin, Kyoto, Japan) was used in this study as an *in vitro* model and was duplicated to aluminum dies. The dentoform tooth then received a preparation with the following features: planar occlusal reduction of 1.5 mm, axial reduction of 1-1.5 mm, 0.8 mm circumferential chamfer finishing line and a 6° total convergence angle a modified dental surveyor.The prepared dentoform tooth was to fabricate 30 aluminumdies for each aluminum dieaconventional impression using two-step putty/ wash impression technique with spacer was taken using a specially designed special tray for this study.The impressions were randomly all located into three groups of 10 each according to thetype of die material;Group A:diestonetype IV (SHER AHARD-ROCK ISO 6873, LOT78083LemfÖrde, Germany);Group B:die stone type V (schouten group dental N chang: 17.2595 Netherland); and Group C:Exakto-form resin die materials (Bredent,Senden, Germany LOT No.52000173). The die materials were mixed and the impression were poured with the die materials following the manufacturers instrections .After setting ,the dies

were separated from their impressions and checked for any defect as air bubbles or imperfection.

InEosX Scanner (Sirona dental system, bensheim. Germany) was used to make ascan for each die model and MCX5 milling unite was used to millIPS e.max CAD crowns with 120µm spacer parameter The marginal gap of the each sample was determined by seating the e-max CAD crownon its own aluminum die with the aid ofaspecimen holding device to provide a standard load of 5 Kg.Adigital microscope (Dino-Lite, Taiwan), was used at magnification of 230X connected to the computer to capture the imageswhich were processed withImage J softwareto measure the marginal gap,sixteen points were selected for measurements,4 for each surface and the average was calculated for each specimens[3].the crowns were then cemented using Rely X U200 (3M ESPE, USA) self-adhesive resin cement withtheaidof surveyor under 5Kg load[4].after cementation , the same points of measurements were re-examined again using the same procedure described previously to calculate the vertical marginal gap.

Findings

Table (1)show the descriptive statistics which includes (mean and standard deviation values) of vertical marginal gaps pre-cementation. The results,is evident that the lowest mean of vertical marginal gap values was scored by group C (55.073±6.299) (while the highest mean of vertical marginal gap values was belonged to group A (76.517±9.152).One-way ANOVA and LSD tests between the studied groups was a highly significant difference (P< 0.01)**.**

The means and standard deviations of the marginal gap which were calculated for each group post-cementation are shown in (Table 2) and it showed that lowest mean value was recorded by group(C) whichwas73.442±6.007while the highest mean value recorded by group (A) which was equal to94.0706±6.694. One-way ANOVA and LSD tests between the studied groups was a highly significant difference (P< 0.01)**.**

Paired samples t-test was used to compare between the e.Max CAD crowns per-cementation and post-cementation ,Table (3) and Figure(3)It is evident that the cement on increased the vertical marginal gap was statistically highly significant degree for all groups**.**

Table (1) Mean distributions of the vertical marginal gaps for the three different die materials groups measured pre-cementation (in micrometer)

Studied groups	N	Mean	SD	ANOVAtest (P-value)	LSDtest (P-value)
Group A(Die stone type IV)	10	76.517	9.152	P=0.00 High sign. (P< 0.01).	P=0.00 High sign. (P< 0.01).
Group B(Die stone type V)	10	65.310	3.433		
Group C (Exakto-form)	10	55.072	6.299		

Table (2) Mean distributions of the vertical marginal gaps for the three different die materials groups measured post-cementation (in micrometer)

Studied groups	N	Mean	SD	ANOVA test (P-value)	LSD test (P-value)
Group A(Die stone type IV)	10	94.071	6.694	P=0.00 High sign. (P< 0.01).	P=0.00 High sign. (P< 0.01).
Group B(Die stone type V)	10	86.965	11.067		
Group C (Exakto-form)	10	73.442	6.007		

Table (3): Paired Samples t- test between all groups' pre- and post- cementation.

Groups		P-Value
Group A	A. pre Vs. A .post	0.000(HS)
Group B	B. pre VS B. Post	0.000(HS)
Group C	C. pre VS C. Post	0.000(HS)

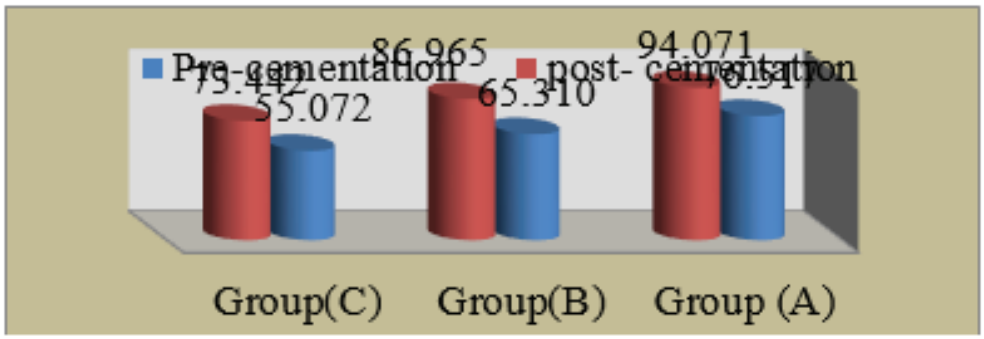
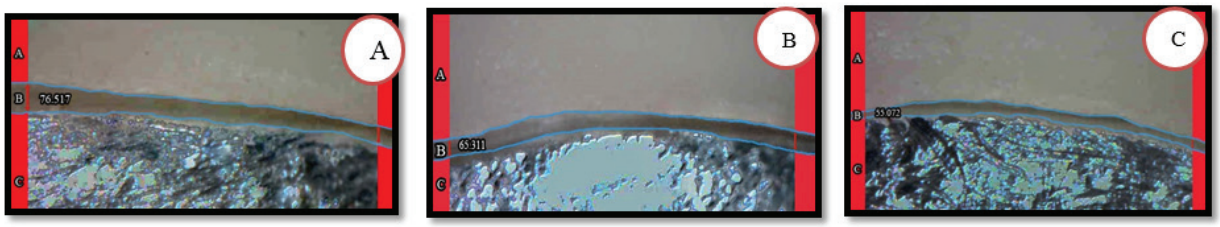
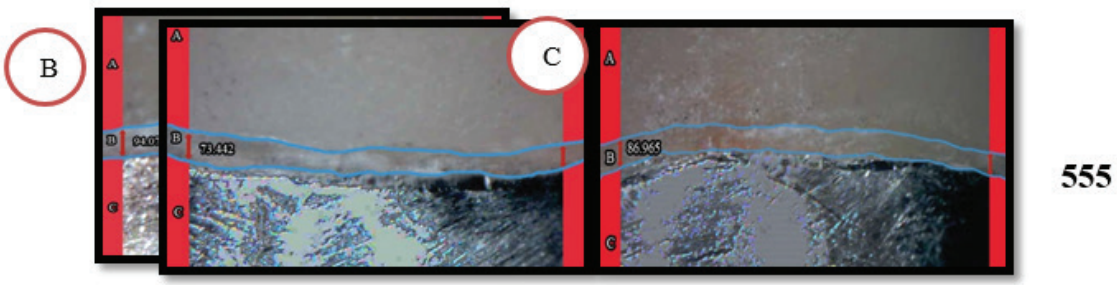


Figure (1): mean values of the marginal gaps for three groupspre- and post-cementation (in micrometer).



Figure(2)Microscopical image of the marginal gap for group A,BandC at a magnificationof 230X per-cementation procedure,(A: Crown, B: Marginal gap, C: Aluminum die).



Figure(3)Microscopical image of the marginal gap for group A,BandC at magnificationof 230X post-cementation procedure,(A: Crown, B: Marginal gap, C: Aluminum die).

Discussion

High marginal accuracy is onsidered to be major determining factor for successful clinical performance of a restoration[5].

The results of this study showed that mean value of vertical gap of the three different groups revealed that at group(C) (Exacto-form) produced statistically the least vertical marginal gap both pre- and post-cementation. The findings was in agreement with [6]who that the mean marginal gap was consistently larger for type IV stone dies than polyurethane resin dies. The superiority of Exacto-form regarding vertical marginal gap in this study could be attributed to:

A.Dimensional accuracy: Gypsum die materials have been reported to exhibit setting expansion of 0.01 to 0.1%. This minimal expansion has been said to compensate for the dimensional changes inherent in the fabrication process of an indirect restoration. The process of gypsum crystallization is an expansive growth of crystals from a core of crystallization. Based on the interlacing of dihydrate crystals, the growth of the core crystals can combine and block the growth of adjacent crystals. If this process is repeated by thousands of crystals during their growth, an external tension will be developed that leads to" "expansion of the mass, and the product of the gypsum reaction is larger than its external volume but smaller in crystalline volume due to dimensional change of die after final set[1]on the other hand polyurethane resin (Exacto-form) was showed lower mean values in the vertical gaps, during polymerization the materials presents low shrinkage(0.060%) this change however was compensated and controlled by increasing the silica filler particles of the mix to 60% resulted in lower polymerization shrinkage of 0.025% to improve the dimensional accuracy of polyurethane die lead to more accuracy fit of indirect full veneer crown comparison gypsum die materials[7].

B.Detail reproduction: Polyurethane resin has ability to reproduce details of up 1-2µm contrary to gypsum material which cannot reproduce details smaller than 20µm due to its crystal structure.With gypsum dies air bubbles are often formed at the interface of the impression and gypsum cast because freshly mixed gypsum does not wet some elastomeric impression materials led to it do not reproduce surface detail resin die materials because the surface of the set gypsum is porous on a microscopic level thus; polyurethane resin "Exacto-form" showed the best performance to the fine details present in this gypsum die[8].

The results of this study revealed that at group (A) produced statistically the highest vertical marginal gap than group (B) both pre- and post-cementation in this study could be attributed to.

A. Dimensional accuracy: Type 4 gypsum differs from type 5 in that type 4, die stone V contain small amounts of extra salts (Sodium chloride) for shortens the setting reaction due to increased more number of nuclei of crystallization per unit volume increases, the setting expansion of the gypsum mass increases of 0.3% of type V stones than the 0.1% setting expansion of type IV stones ,the desirable in this technique because it compensates for the contraction of the framework metals especially base metals)[9,10,11]. On the other hand, setting expansion of the gypsum mass decreases it causes deformation of the prepared tooth was removed from impression might be another possible source for such inaccuracy[12].

B.Detail reproduction: Die stone type V has ability to reproduce details than the die stone type IV because it had on Sodium citrate is a dependable retarder. Borax, Na2B4O7, is both a retarder and accelerator. A mixture of calcium oxide (0.1%) and gum arabic (1%) resulting in improved properties, compressive strength, hardness, abrasion resistant and reproduction details than the die stone type V ,all properties with effected direct impact on fitted of final restoration.[7,13, 14].

2.Effect of cementation process

The results showed that after cementation ,the vertical marginal gap incressed significantly . The cement layer may increase the marginal gap uncontrollably and unequally depending on the cement viscosity.one study revealed that the marginal gap increased by 18 to 22 µm when the crown was luted with cement. The high viscosity in self-adhesive cement resin create the problem of escape of excess cement and hydraulic pressure that is going to push the cement upward, this will result in great amount of luting cement to be accumulated on the occlusal surface of the prepared tooth, probably caused interfere with proper seating of crown restoration and prevents the crown from complete seating post-cementation process[15,16].Vertical marginal gap values were increased significantly post-cementation; this is in total agreement with other previous studies: [5,17,18,19,20,21].

Conclusions

Exacto-form resin showed better vertical and horizontal fitness than both die stone type IV and die stone type V.Cementation process significantly increased the vertical marginal gap values for all groups regardless the type of die materials but still within the clinically acceptable (< 120 µm).

Conflict of Interest: non

Source of Findings: self

Ethical Clearance: This research was carried out with the patients .

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