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ASSESSMENT OF CERAMIC REPRESSING EFFECT ON INTERNAL FIT OF TWO DIFFERENT PRESSABLE CERAMIC MATERIALS

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ABSTRACT

Objective: The aim of this study is to evaluate the effect of ceramic repressing on internal fit of two different pressable ceramic materials.

Materials and Methods: Two commercially available glass ceramic materials were used in this study; IPS E-max press (Ivoclar, vivadent) and Celtra press (Dentsply, Sirona). The two materials were used to fabricate veneer samples as which a total of twenty veneers were constructed. The samples for each material(n=10) were randomly divided into two equal groups; Group A: Pressed specimens (n=5) veneer shaped wax patterns were invested and heat-pressed according to the manufacturer's recommendations and Group B: Re-pressed specimens (n=5) the leftover material from 1st pressing was recovered and the buttons were adjusted to fabricate the specimens by repeated heat-pressing using the same procedures as for (A The internal gap distance between the veneers and the resin dies substance ware measured with the stereomicroscope at three preselected locations at 70× magnification. Internal fit adaptation was recorded and mean values for each group determined. Data was statistically analyzed.

Results: For IPS E.max or Celtra press; there was no statistically significant difference between mean values of press and repress conditions (P <0.05) between tested groups. It was found that internal gab mean values was recorded for Celtra repress recorded (96.6±6.4) µm which was the highest value which gave poorest fit then E-max repress was recorded (92.6±7.6) µm , Celtra press recorded (91.8±2.8) µm, however E-max press recorded (91.6±5.6) µm which was the lowest mean value for internal fit test.

Conclusions: The optimum properties for lithium disilicate Press ceramic materials are obtained with the first pressing. However the microstructure and mechanical characteristics could be impacted by numerous heat repressions, but there would be no statistically significant change in how the internal fit would adjust.

KEYWORDS: Repeated heat pressing, ceramic repress, internal fit

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INTRODUCTION

Increasing interest in ceramic-fixed prostheses has followed improvements in aesthetics, strength and ease of fabrication. More recently, a lithium disilicate-reinforced multiphase glass-ceramic system with a high degree of crystallinity was presented.

Zirconia reinforced glass ceramics (Celtra Duo, Celtra Press), which are produced using CAD/CAM system and pressing technology, for example, have been developed in response to the ongoing demand for all ceramic restorations that combine excellent aesthetics and optimal mechanical properties[1].

Glass-ceramics combine characteristics that are common to both ceramics and glasses while displaying some compositional and microstructural variations[2]. The processes of sintering, slip casting, heat pressing, and milling are used to create ceramic restorations[3]. Sintering and slip casting are inferior to heat pressing in terms of porosity and marginal fit[4].

There are two generations of pressable ceramics; the first is based on leucite, while the second is based on lithium disilicate[5, 6]. Due to their superior flexural strength and fracture toughness compared to other crystalline forms of pressable ceramics, lithium disilicates have gained relevance. Despite this, lithium disilicates are still weak and cannot be employed in high-stress situations[7].

To meet a variety of therapeutic needs, there are ingots with various tones of leucite- and lithium-disilicate-reinforced glass-ceramic materials. These ingots are heated and then heated-pressed into a mould in a pneumatic press furnace during laboratory processes.

The button and sprue sections are removed and typically discarded after pressing and chilling. However, some dental laboratories have discovered that these leftover materials can be used for re-pressing because it is more economical to reuse what is frequently wasted material to press a number of restorations, which reduces the amount of wasted material. Repressing unused material will also save environmental resources and cut down on patient treatment costs. In order to decide whether repeated heat-pressing treatment of glass ceramic material is feasible, it is crucial to assess the qualities of the material. It is assumed that recycled materials will maintain the same microstructure and mechanical properties as the initially pressed material after being heated repeatedly.

The aim of this study is to investigate the effect of repressing IPS e.max Press and Celtra press on the internal fit of ceramic veneers. The hypothesis is that ceramic repressing will not affect the internal fit as those of one heat-pressing

MATERIAL AND METHODS

Two commercially available glass ceramic materials were used in this study; IPS e.max press (Ivoclar, vivadent) and Celtra press (Dentsply, Sirona). The two materials were used to fabricate veneer samples as which a total of twenty veneers were constructed. The samples for each material (n=10) were randomly divided into two equal groups; Group A: Pressed specimens (n=5) veneer shaped wax patterns were invested and heat-pressed according to the manufacturer's recommendations and Group B: Re-pressed specimens (n=5) the leftover material from 1st pressing was recovered and the buttons were adjusted to fabricate the specimens by repeated heat-pressing using the same procedure as for (A).

A natural extracted maxillary central incisor which free from any pathosis, the tooth which collected was kept in thymol 0.1% to avoid dehydration. The tooth was mounted in epoxy resin blocks using a special device (parallometer).

Self-limiting depth-cutting of 0.5 mm (NTI, kerr dental, USA, 0.5 mm, .03mm) were used to define the depth cuts, followed by a diamond bur

(Kerr dental, USA). to refine the preparation. Thicknesses of the labial surface were prepared 0.5mm. No incisal reduction, however, the tooth's labial surface was reduced in order to place a 0.2mm bevel and reduce the tooth's facio incisal surface by 0.5mm.

Twenty resin dies of yellow shade were fabricated to act as replica for a prepared upper central incisor. The resin dies (Resin ABS-V2.0 yellow, power resins, 3BFAB, Teknoloji A.Ş., Istanbul, Turkey) were obtained by scanning the prepared teeth by extraoral scanner (T310, Medit, Korea) and then printed by 3D Printer (Mars 3, Elegoo, china) which used for duplication and making an exact replica for the prepared status.

The resin dies scanned using laser scanner. The wax-patterns (power resins, 3BFAB, Teknoloji A.Ş. Istanbul, Turkey) were produced with 3D printer using laboratory cast scanner to digitize the dies, after they were sprayed with scan spray, then twenty standardized wax patterns designed were fabricated on ready dies in which the wax patterns were designed with a thickness of 0.5mm.

The wax patterns were sprued (Kerr, Orange, CA) and then Sprues were attached to the IPS silicon investment ring System. The ring was filled with investment material and was allowed to set for 35 minutes. The investment ring was placed in the preheated furnace (Vulcan 3-130, Degussa-Ney Yucaipa, CA, USA). The ceramic ingots of IPS E.max (Ivoclar-Vivadent, Schaan, Liechtenstein), Celtra (Dentsply Sirona, NC, USA) Press were then plastified and pressed under vacuum into them old of the investment in a press furnace (EP600 combi, Ivoclar-Vivadent, Schaan, Liechtenstein).

The heat-pressing conditions were as the manufacturer instructions. The investment moulds were pressed, then taken out of the furnace and let to air cool.

The specimens were then gently divested using a 3 bar air abrasion apparatus and 50 µm glass beads. Following the cutting of the button and sprue parts, 10 specimens were chosen at random. The button and sprue sections of the remaining specimens were ground down to ensure correct insertion into the refractory moulds for repeated heat-pressing. Additional 10 specimens were created under the identical heat-pressing circumstances.

Bonding protocols were followed in cementation of all veneers according to the manufacturer's recommendations to avoid any variables during bonding procedures. The veneers were cemented using Bisco Biscem dual cure self-adhesive resin cement(Choice2,Bisco,USA).Tomakesureaprecise reproduction of clinicaly relevant environments, luting techniques adhered to clinical regulations. All specimens were subjected to thermocycling procedures in automated thermocycling machine to mimic the oral conditions. The samples were thermocycled for 5000 cycles, between 5°C-55°C with a dwell time 15 seconds.

The specimens were embedded in mold with clear acrylic epoxy resin and when the acrylic resin were completely set, the specimens were removed from the mold and any excess were cut off for preparing the measurement under stereomicroscope.

The specimens were sectioned by isomet device (4000 saw Buehler, USA) in two directions (Mesio-Distally and Facial-Lingual) .The internal gap distance between the veneers and the resin dies substance ware measured with the stereomicroscope at three preselected locations at 70× magnification.

On a computer monitor, magnified images of the measurement places were shown, and computer software (Lucia G on Meteor, Version 4-51 for Nikon Laboratory) was used to digitally estimate the distance between the dentin-like position and infrastructure as showed as in figure (1).

All external measurements were taken 50 µm from the outermost margin in order to prevent interpretation errors brought on by extra cement.

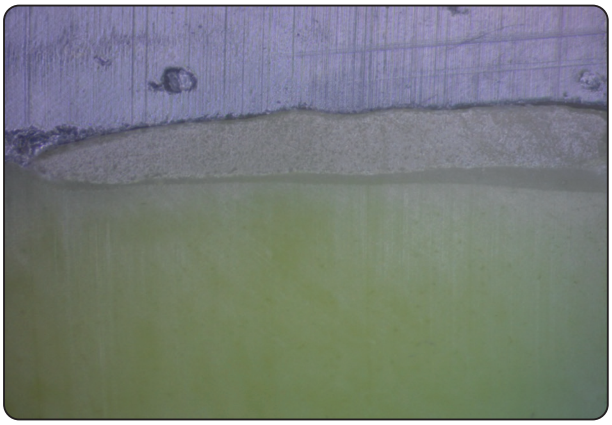

Fig. (1) internal gab under StereoMicrscope

RESULTS

The results showed that ceramic material, technique and the interaction between the two variables had a statistically insignificant effect on mean values of internal fit.

It was found that internal fit mean values was recorded for Celtra repress recorded (96.6±6.4) µm which was the highest value which gave poorest fit then E-max repress was recorded (92.6±7.6) µm, Celtra press recorded (91.8±2.8) µm, however E-max press recorded (91.6±5.6) µm which was the lowest mean value for internal fit test . The difference between groups was statistically insignificant as indicated by two way ANOVA test ***P value < 0.05***

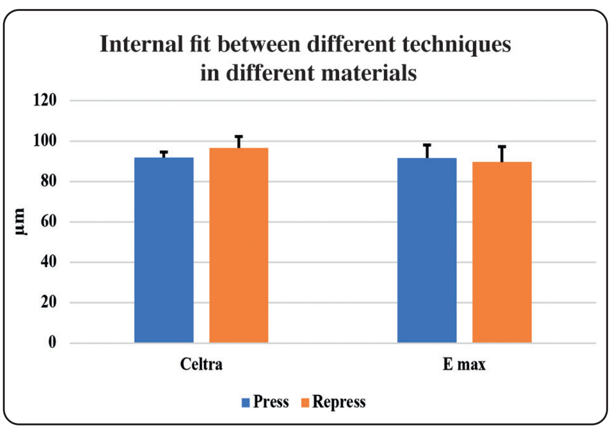

Fig. (2): Histogram showing internal fit mean values for press and repress in two materials (E-max and Celtra).

DISCUSSION

One of the most crucial elements for effective prosthetic therapy is the internal and marginal fit of a fixed prosthesis[8, 9]. A perfect restorative fit prevents cement disintegration and upholds a healthy state of the gums[10, 11].

On the other hand, it is challenging to execute long-term maintenance of the patient's health due to the detrimental effects of a poor marginal fit on the periodontium[12-14].

In addition, an excellent interior fit improves the prosthesis' retention. [15]. For these reasons, The marginal and internal fit of prostheses have been the subject of various investigations to ascertain their prognosis[16]. To reduce the inhomogeneities and porosities that frequently appeared during traditional sintering, heat-pressable ceramics were created[17].

In this investigation, a stereomicroscope was used to assess interior fit. Elrashid et al. (2019) claim that it is a straightforward and practical procedure[18].

As a number of clinical trials and in vitro research have been carried out to assess marginal and internal gap sizes, the resultant internal gap mean values in the current study were found to be within the clinically acceptable range. There have been reports of acceptable fit-discrepancies between 50 and 150 µm[19-21]. The strength and internal fit of the restoration were enhanced by improvements in dental ceramic materials and processing processes[22].

The result in this study revealed that E-max press group mean values recorded (91.6±5.6) µm which was the lowest internal gab mean value as which statistically insignificantly with chipping mean values of Celtra repress group which was recorded the highest internal gab mean values (96.6±6.4) µm, while celtra press mean values recorded (91.8±2.8) µm and E-max repress group mean values recorded (92.6±7.6) µm.

The findings of this investigation could have implications for the detrimental effects of repressing on physical and mechanical properties as well as the modification of IPS e.max Press's microstructure that Tang et al. (2014) observed[2].

Some of the factors that may impact the gap size and seating of a repair include preparation geometry, margin configuration, surface polishing, manufacturing method, cement type, cement layer thickness, cementation technique, and pressure[23].

However, due of numerous nucleation sites created by the crystallisation process, there is a chance of increased porosity and cracks during repressing processes. These porosities and fissures are defects in the finished repair and may negatively impact how long they last[24].

Tang X. et al investigated the impact of re-pressing on IPS e.max Press's mechanical characteristics and microstructure. They concluded that the microstructure changed following re-pressing, and an increase in porosity was seen. Furthermore, there was a considerable decline in density, hardness, flexural strength, and fracture toughness[2].

When it comes to the lithium silicate glass-ceramic system, P2O5 works well as a nucleation agent [25, 26]. P2O5 addition increased the pace at which the stable lithium disilicate (Li2SiO5) phase formed during the crystallisation of the glasses while also causing the development of Li3PO4 crystals [27-29].

Additionally, it has been demonstrated that the primary phases that form during the crystallisation process in a glass ceramic system are lithium metasilicate (Li2SiO3), lithium orthophosphate, SiO2, and lithium disilicate (Li2SiO5). The Li3PO4 crystallines may also serve as sites for the nucleation of stable lithium disilicate[29].

Therefore, the microscopic pores discovered by SEM in the microstructure of the glass-ceramic reinforced with lithium disilicate may have been precipitates of Li3PO4. ZnO addition has been shown to improve the chemical stability of glass-ceramics by encouraging the crystallisation of SiO2 and silicate minerals[30].

Following heat pressing, the lithium disilicate crystals' porosity and cracks were also found by the SEM. Because the lithium orthophosphate phase etched more quickly than the lithium disilicate phase, this might be the outcome of the dissolution of the lithium orthophosphate crystals in the glass matrix and at the grain boundaries of the lithium disilicate crystals. Another explanation for the rise in porosity and cracking may be that there were several nucleation sites during crystallisation[31].

Tang X. et al 2014[2] found that the examples were ground, polished, and cleaned following one or two heat pressing cycles, leaving all of them with surfaces that ranged from 0.143 to 0.144 m in roughness. Surface roughness variations between any specimens did not prove to be significantly different. This can be the result of using the same grinding techniques and procedures on each specimen. This complies with ISO 6872: 2008's recommendations. According to this ISO, the test specimens' surfaces must be smooth with a roughness of less than 0.5 µm[2]. Some dental laboratories may consider the practise of reprocessing leftover materials just once to be acceptable[24].

The hypothesis was accepted based on the data, as there was no discernible variation in internal fit between the initial heat pressing and the subsequent heat pressing

CONCLUSIONS

The findings can be distilled into the following statement within the limitation of the current study:

1. The optimum properties for LiSi Press are probably obtained with the first pressing. However, repeated heat compressing could

change the mechanical and microstructural characteristics of the LiSi Press, but not the minor chipping problem.

2. Further investigation could be done for the effect of much heat repressing cycles and different weight percentage of new and repressed ceramics on chipping of the material.

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