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A Comparative Evaluation of Marginal and Internal Adaptation of Pressed and Layered Zirconia Ceramic Crowns: An In Vitro Study

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ABSTRACT

Aim: **T**o evaluate and compare the marginal and internal adaptation of zirconia crowns veneered by two different techniques.

Materials and Methods: Sixteen standardized zirconia coping were fabricated and divided into 2 veneering groups (n=8) as follows; Group 1 – (Pressed crown) using the Heat Pressing technique and Group 2 (Layered crowns) using Conventional layering technique. The marginal and internal adaptation of crowns was measured on the resin master dies using Silicone Replica Technique. The replicas were sectioned with a blade mesiodistally (MD) and buccolingually (BL). These sectioned replicas were scanned under stereomicroscope (40 x magnifications). Unpaired t-test was used to evaluate mean marginal and internal adaptation changes.

Results: After veneering, the mean marginal gap values of Pressed crowns were 106 µm and Layered crowns was 124 µm. The mean internal gap of Pressed crowns was 50 µm and Layered crowns was 66 µm. There was significant effect of different veneering techniques on Marginal and Internal adaptation of on zirconia copings ($p<0.05$).

Conclusion: Layered crowns showed higher values than pressed zirconia crowns. Hence, Pressed crowns show significantly better marginal and internal adaptation than conventional layered veneered crowns.

Keywords: Marginal adaptation, Zirconia crowns, Pressed Crowns, Internal adaptation.

INTRODUCTION

Achieving esthetically and functionally ideal restorations has been the goal of dental clinicians, throughout the history of dentistry.[1] Crown adaptation along with high marginal accuracy, esthetic value are important to the clinical success and longevity of crown restorations.[2] Great marginal discrepancies expose the luting material to the oral environment, thus leading to a more aggressive rate of cement dissolution, caused by oral fluids and chemo-mechanical forces. The cement seal becomes weak and permits the percolation of bacteria. Consequently, the longevity of the tooth could be compromised by caries and periodontitis. Many studies provide evidence that a large marginal discrepancy in a fixed restoration correlates with a higher plaque index and reduced periodontal conditions. [3]

Marginal gap values between 100 µm and 150 µm are considered clinically acceptable. In addition, internal adaptation is also important because gap greater than 70 µm can reduce the fracture resistance of dental crowns.[4] Given the importance of the fitting accuracy of restoration, there has been

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much debate on the consequence of veneering porcelain on the marginal fit of all-ceramic restoration. The replica technique (RT) has been widely used because of its ability to estimate the internal and marginal gap dimension of prosthetic restorations. This technique is non-destructive, accurate and reliable method that has been used in vivo and in vitro, using stereomicroscope.[5] The purpose of this in vitro study was to evaluate and compare the Marginal and Internal adaptation of pressed and layered zirconia crowns.

MATERIAL AND METHODS

One extracted caries free maxillary central incisor tooth was prepared with a shoulder margin, round internal angle, 1.5 mm axial reduction, 2 mm occlusal reduction, 6° convergence. 16 Epoxy resin master dies were fabricated by duplicating the prepared incisor tooth with polyvinyl siloxane impression material. Resin dies were divided into 2 groups to receive crowns veneered with two different techniques.

Group 1:- Pressed Crowns
Group 2:- Layered Crowns

Zirconia coping

The die scanned and zirconia copings were designed using a standard protocol with a uniform thickness of 0.5 mm around finish lines, 0.8 mm occlusal and axial wall thickness, 30 µm spacer, and 1 mm short of the margin. Sixteen zirconia copings were fabricated using CAD/CAM milling machine from pre-sintered ZIRCONIA blanks (IPS1 e.max ZirCAD, Ivoclar Vivadent). The copings were then assigned to 2 groups for veneering technique.

For heat pressed technique, wax pattern for veneering layer was fabricated and invested with zirconia coping (Virovest-Bellavest). After wax burn-out procedure, Ceramic Pressable Ingots (VITA PM 9) were pressed in pressable ceramic furnace (Vita Furnace), according to the manufacturer's instructions. Heat up temp (850 °C) Pressing temp (1000 °C), Press time (6 min). After divesting, the sprues were cut using diamond disc and burs and the remnants of the investment material were cleaned. The restorations were then glazed.

For traditional layering technique, a standardize silicone index was used for homogenous veneering thickness of range between 0.7 mm at margins and 1.5 mm at occlusal surfaces.

All copings were veneered using silicate-based opaque veneering ceramic (VITA VM 9; VITA), according to the manufacturer's recommendations. First, layer of bonding agent was applied and fired at 980°C. Then, base dentin layer was fired at 950°C. Afterwards, a color liner was applied and fired at 930°C. The first dentin firing cycle was performed at less than 910°C and the second firing cycle was performed at less than 900°C. Finally, glaze firing with glaze fluid was performed at 900°C.

Marignal and Internal Adaptation

The fit of these restorations was evaluated using the Silicone Replica Technique (RT). Copings were filled with polyvinyl light-body and placed on the dies using finger pressure on the occlusal surface to mimic the insertion step of a crown.

The replicas were stabilized using heavy body. The replicas were removed sectioned with a blade mesiodistally (MD) and buccolingually (BL). These sections replicas were scanned under stereomicroscope (40x magnifications) to measure the internal and marginal fit (Fig.1).

For internal adaptation total 3 measurements were taken at 3 different points along vertical gap. Marginal and internal gap mean values and their standard deviations (SD) were calculated. Data was statistically analyzed using Unpaired t-test.

RESULTS

Statistical analysis shows, Mean Marginal Adaptation of Conventional layered group (124.11) is higher than Heat Pressed group (108.54).

Mean Internal Adaptation of Conventional layered group (66.22) is higher than Heat Pressed group (50.64). The result of comparison of two groups using unpaired t-test shows statistically significant difference ($p<0.05$). [Table 1]

Table 1: Comparison of Marginal and Internal Adaptation between Pressed and Layered groups (unpaired t test).

Group	Pressed		Layered		P value
	Mean	SD	Mean	SD	
Marginal adaptation	108.5	10.3	50.6	8.5	.004
Internal adaptation	124.1	6.8	66.2	8.7	.003

DISCUSSION

The increasing demand for more natural-looking crowns has led to introduction of different fabrication techniques and development of a new generation of ceramics that delivers excellent aesthetics good biocompatibility and sufficient strength [2-3].

In the past decade, dental manufacturers have focused their efforts on Yttrium-tetragonal zirconia poly-crystals (zirconia) is one of these products that has received special attention due to its high flexural strength and fracture toughness. However, zirconia-based products cannot provide optimal esthetics because they possess high opacity and are difficult to stain. Therefore, zirconia must be used as a core material and clad with veneering porcelain to enhance esthetics. At the early stages in the history of zirconia-based crowns, veneering porcelain was layered manually on the core material and sintered similar to metal-ceramic crowns.[6]

The success of a restoration is determined by various factors, among which is the marginal fit of the restoration. Lack of adequate fit is potentially detrimental to both the tooth and the supporting periodontal tissues, due to cement solubility or plaque retention. For that reason, adequate sealing is essential for optimal clinical performance. The purpose of this investigation was to determine whether the different veneering techniques of zirconia crowns could affect the marginal and internal adaptation and fracture toughness of the restoration. There are large variations regarding the amount of acceptable marginal gap of crown in the literature. Christensen et al[7] reported the range of 34-119 µm as acceptable marginal gap. Mclean et al[8] evaluated more than 1000 restorations within 5 years, and proposed 120 µm as the upper limit of clinically acceptable marginal opening.

Torabi K et al[9] in his study concluded that veneering methods altered the marginal fit of zirconia copings. Conventional layering technique increased the marginal gap of zirconia framework more than heat pressing technique. Dessouky et al[10] reported significant increase in the measurement of vertical marginal (internal) gap was observed after firing the conventional veneering layer (46.87 ± 3.94 mm). Kohorst et al[11] reported that the veneering of zirconia restorations may lead to significant changes in the marginal and internal fit, while the combination of core and veneering material used influences the resulting distortions.

Alterations of the marginal and internal adaptation during veneering process could be discussed by some causes. The probable reason are shrinkage of veneering porcelain during sintering process, numbers of firing cycles needed for each of these techniques. Conventional layering technique needs more firing cycles (at least five) compared to the heat pressed (at least three) veneering techniques. This improvement in adaptation of crown was reflected in the clinical performance of zirconia-based restorations with significantly for pressed veneering crowns than for manually applied veneering crowns.

Some of the limitations of the present study are that, specimens were produced and tested under the ideal conditions, which may not reflect the actual clinical conditions. There may be possible errors in microscopic evaluation of the marginal and internal gap. In the case of sectioning of replica, the number of measurements per specimen is limited.

Further studies based on additional variables should be conducted and further evaluation of bond strength between different ceramic and veneering material and techniques should be studied.

CONCLUSION

Within the limitations of this study, following conclusions are drawn:

Two different veneering techniques had a significant effect on Marginal and Internal adaptation. Heat Pressed veneered crowns showed

better adaptation than conventionally layered crowns. Pressing technique seems to be a promising option for improving the performance of the crowns in comparison to conventional techniques.

CONFLICT OF INTEREST

No potential academic conflict of interest relevant to the above article was reported.

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