The Effect of Different Preparation Designs & Cement Type on the Marginal Adaptation of All-Ceramic Cantilever Anterior Fixed Partial Dentures

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Abstract: Objective: This *in vitr*o study is designed to evaluate the effect of Different preparation designs a) Full coverage retainer, b) Conventional Partial coverage retainer and c) Partial coverage retainer with labial extension: cemented using two Cements Resin Cement and Glass Ionomer Cement on the marginal adaptation of all ceramic cantilever anterior fixed partial dentures; the type of the ceramic material used was Partially stabilized Yttrium-tetragonal zirconia polycrystals (Y-TZP). supplied by VITA Zahnfabrik H. Rauter Gmbh and Co.KG./Germany.The bridges fabricated using *Cerec* in lab CAD/CAM System which include (Cerec -3 acquisition unit and inlab MC XL milling unit) introduced by Sirona, bensheim, Germany.
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1. Introduction

Over the past decade, increased demand for esthetically pleasing restorations has led to the development of all-ceramic systems. Nowadays, it is unquestionable the importance of the development of ceramic materials in substitution to the prostheses with conventional metallic infrastructure. When applied in selected cases, these materials present some positive aspects, in what it concerns to the biocompatibility and extremely favorable aesthetics[(1)].

On the other hand, the functional aspect of the restoring systems has to be evaluated from way to provide safety in the clinical use of these materials. This way, the evaluation of the marginal adaptation of ceramic crowns is of extreme importance for the scientific proof of clinical situations, once the precision of adaptation among the substitute material to the lost dental structure and the tooth is directly related to the longevity of the prosthesis. In this work, we evaluated the effect of preparation designing and cement type on the marginal adaptation of zirconia anterior cantilevered fixed partial denture.

Zirconium, a high-strength ceramic, was recently introduced for dental use as a core material for conventional and resin-bonded FPDs and complete coverage rowns.[(2,3).] The use of the zirconium-oxide all-ceramic material provides several advantages, including a high flexural strength (1000 MPa) and desirable optical properties, such as shading adaptation to the basic shades and a reduction in the layer thickness (compared to conventional ceramics) of the veneer ceramic required to achieve the desired color [(4, 5)] of the material, the cementation technique is also important to the clinical success of a restoration.[(6,7)]

In order to produce a ZrO2 core for a prosthetic Restoration, it is necessary to use a computer aided design / manufacturing (CAD/CAM) system that can deal with zirconia and create a fitting framework. Various production techniques have been developed for enhancing the fabrication of consistent and predictable restorations in terms of strength, marginal fit, and esthetics. The Cerec system (Sirona, Bensheim, Germany), was selected since it is the most famous system that has been marketed for several years (since 1986).

The reproducibility of the CAD/CAM systems would seem to have better results because the metal ceramic technique involved the use of die spacers to allow space for the cement, whereas in the CAD/CAM method, the space for the cement is adjusted during the manufacturing process.

2. Materials and methods

In this study, three all-ceramic (Zirconia) cantilever fixed partial denture retainer designs restoring missing upper lateral incisors using maxillary canine as an abutment has been evaluated.

The first retainer design has been a full coverage retainer, the second has been a three quarter partial coverage retainer with proximal grooves, and the third has been a three quarter partial coverage retainer with proximal grooves and extending on the labial surface to end with a rounded shoulder finish line.

A total of 30 all-ceramic (Zirconia) cantilever bridges has been divided according to retainer design into three groups (10 bridges each).

Each group has been further divided according to the type of cement into two subgroups (5 bridges each).

An upper maxillary canine has been prepared to receive different retainer designs; duplication of the preparation has been performed using duplicating material. All ceramic cantilever fixed partial dentures have been fabricated according to the manufacturer instructions.

All of the bridges have been tested for marginal adaptation using stereomicroscope and photo analyzed before and after cementation (figure 1).

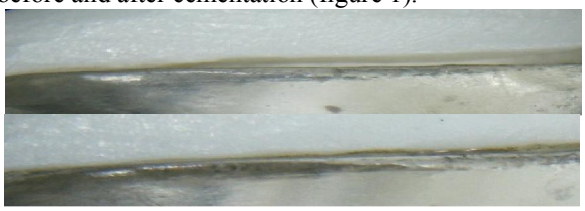

Figure 1: showing marginal gap before and after cementation

Results

Data analysis was performed in several steps. Initially, descriptive statistics for each group results. Three factorial analysis of variance ANOVA test of significance comparing variables affecting mean values (preparation design, cementation and cement). One way ANOVA followed by pair-wise Newman keuls post-hoc tests were performed to detect significance between preparation groups. Statistical analysis was performed using *Graph-Pad Prism-4* statistics software for Windows. P values ≤0.05 are considered to be statistically significant in all tests.

The mean values and standard deviation of marginal gap (μm) as function of preparation design and cement are summarized in table (1) and graphically drawn in figure (2).

Table (1) Marginal gap results (Mean values± SDs) as function of preparation design before and after cementation with each cement type.

Variables		*Cement*			
		Before	*After Resin*	*After GIC*	*ANOVA*
		Mean±SD	*Mean±SD*	*Mean±SD*	*P value*
Preparation design	*Partial coverage*	54.73^{A} ± 9.9	61.93 ± 9.8	64.79 ± 13.4	0.2288ns
	Modified p. coverage	58.92^{A}± 10.2	58.56 ± 12.8	58.51 ± 17.9	0.9976ns
	Full coverage	44.67^{B}± 8.8	51.65 ± 13.7	58.59 ± 20.1	0.2288ns
	ANOVA (P value)	0.0007*	0.3938ns	0.9999ns	

Different letter in the same column indicating statistically significant difference ($p< 0.05$).
*; significant ($p< 0.05$). ns; non-significant ($p>0.05$).

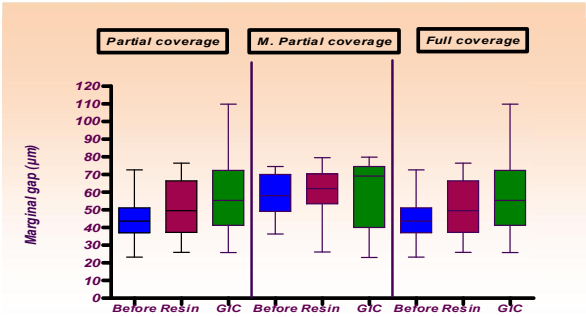

Figure (2) Box plot of marginal gap mean values as function of preparation design before and after cementation with each cement type

4. Discussion

Three preparation designs were investigated during this study. The full coverage, as a standard preparation, that provides the ultimate resistance and retention to restorations. The conventional three quarter preparation, a well suited design for short span anterior bridges as it provides good mechanical and esthetic properties as well as being conservative. [8,9] A proposed modified three quarter preparation design, that stands midway between the fore mentioned full and partial coverage preparations. Increasing the depth of reduction in the conventional three quarter preparation quarter, to accommodate the required minimum thickness of zirconia, compared to metal would probably weaken the incisal one third of the abutment tooth. Thus the proposed modification in the partial coverage preparation by reducing 2 mm of the incisal edge was done to provide better incisal protection and act as a horizontal stop that provides better vertical support.

A uniform 1mm shoulder finish line that followed the scallop of the free gingival margin, 2mm incisal and 1.5mm axial reduction with a 6 degree taper. All sharp point and line angels were rounded off. [10]

Dimensionally accurate die materials are critical to the fit of fixed prostheses. The benefits of an accurate die material become even more important as the span and complexity of the prosthesis increases.

One aspect to be investigated is the fit of the inner surface of the prepared tooth, defined as Discrepancy or gap which can be internal and/or marginal. An internal discrepancy is the misfit of the coping at the occlusal /incisal ad axial surfaces. Marginal discrepancy is the vertical dimension from the finish line of the preparation to cervical margin of the restoration. A marginal gap ranging 10 to 500 um with mean values from 50 to100 um, have been

reported, even higher values have been found for incisal/occlusal discrepancy [11, 12].

This study is done to evaluate the effect of different preparation designs and two cements on the marginal adaptation of zirconia cantilevered fixed partial denture.

The dental laboratory procedures, the manual skills and the experience of the dental technician have a decisive influence on the marginal gap width. Consequently, all restorations employed in the present study were fabricated by the same master technician to ensure that these factors did not change for the individual test groups. Also, all measurements were made by the same person to avoid errors as much as possible. *In vitro* and *in vivo* studies that have examined the width of the marginal gap of all-ceramic partial coverage restorations are in short supply.[13]

Effect of preparation design: before the cementation procedure it was found that both modified partial coverage group and partial coverage group recorded statistically significant higher marginal gap than full coverage group. This may be attributed to the complicated marginal configuration plus the presence of retentive grooves in the partial and modified partial coverage preparations as these features complicate the seating of partial coverage restorations in comparison with the ease of seating in the full coverage restorations.

However after cementation the large initial gap, which facilitates the flowing off of luting material during the cementation process, may explain why the cement width increased to a lesser degree in partial and modified partial coverage group than it did in full coverage group. Thus the full coverage group, which showed the best initial fit, produced the largest increase in marginal gap after cementation. The good initial fit and the size of the restoration surface and margin may have diminished the capability of the luting cement to flow off and consequently may have been conducive to increasing the vertical marginal gap by the cement of this group.

This was in accordance with *in vitro* study done by **Stappert**[14], in which, 80 extracted human maxillary molars were restored with MOD inlay restorations and four different modified partial coverage restorations using a new press ceramic IPS e.max Press. The teeth were divided into five groups of 16 specimens each and prepared as follows: Group A received an MOD inlay preparation and Group B, C, D and E received the different modified partial coverage restorations. The restorations were adhesively luted and exposed to a mastication simulator. The discrepancies of the marginal fit were examined on epoxy replicas before and after luting as well as after masticatory simulation. The results of this in vitro study showed that the preparation design and dimensions of the restorations appeared to affect the initial marginal fit and flowing off of luting material during the cementation process. Before cementation, significantly larger mean cement joints were measured in the specimens that were restored with conventional inlay restorations (Group A) than in the ones that were restored with modified partial coverage restoration. The mean thickness of the cement joints gradually decreased as the number of cusps included in the restorations increased. This could explain that the modified partial coverage group in our study showed nearly no increase in marginal gap after cementation in comparison with the partial coverage group, as the more surface coverage in modified partial coverage group by extension on the labial surface offered extended margins which allowed more free ways for escapement of the luting cement.

Effect of cementation procedure: It was found that after cementationmarginal gap mean value was higher than before cementation regardless to the preparation design or cement type, and this may be attributed to the added thickness of luted cement on the marginal gap. ***Gemalmaz***[15] also described an increase in the marginal gap of ceramic inlays after cementation.

Basically, the increase in marginal gap width after cemntation is caused by the volume requirement of the luting cement, depending on particle size, flow properties, and consistency.[116,17]

The marginal gaps measured for all three test groups before and after cementation were on average in the range of 55.89, a value defined as clinically acceptable.[18]

Opinions on the clinical relevance of the size of marginal discrepancies are controversial. Most authors agree that marginal discrepancies in the range of 100 µm seem to be clinically acceptable with regard to longevity of the restorations.[18,19]For other authors, marginal discrepancies up to 200 µm are acceptable.[20]

An explanation of the lack of agreement may be the variation in the methods used by investigators studying marginal fit. ***Sulaiman et al.***[21] suggested that the cause could be the use of different measuring instruments, Sample size and number of measurements per specimen may also have contributed to the variation.

Effect of the type of cement: The results showed that after cementation there is no significance increase in the marginal gap for glass ionomer followed by resin cement.

This was supported by a study done by **Xin-Hua Gu,**[22] who evaluated the marginal discrepancies and leakage of all-ceramic crowns cemented with different luting agents before and after fatigue tests, he cemented Forty-eight all-ceramic crowns onto natural molars. Zinc-phosphate cement, compomer cement,

and an adhesive composite resin luting system were used in 16 specimens each. Sixteen metal-ceramic crowns were cemented with zinc-phosphatencement as a control. Half of the specimens in each group were fatigued in a chewing simulator for 600,000 loading cycles with 3,500 thermocycles. The others received the 3,500 thermocycles only. He found that the marginal discrepancies of the all-ceramic crowns cemented with three luting agents were all significantly smaller than those of the metal-ceramic Crowns and no significant difference was found among the luting agents.

These results support other findings [23,24] which showed that conventional cementation and adhesive luting of crowns result in similar marginal discrepancies.

Mohamed [25] studied the effects of tooth preparation burs and luting cement types on the marginal fit of extracoronal restorations, The cements used were zinc phosphate, glass ionomer and resin cement. He concluded that luting cement type had no significant effect on marginal gap.

Conclusion

Within the limitations of the present study the following conclusions could be drawn, all bridges of different preparation designs and type of cement used were within the clinically acceptable marginal adaptation range.

Preparation design had affected the marginal adaptation measurements before the cementation procedure buthad no effect on the marginal adaptation measurements after the cementation procedure.

Null Hypothesis:

Neither preparation design nor cement type has a significant effect on vertical marginal gap.

There is no significant difference in the vertical marginal gap before and after cementation.

References

1. Christensen GJ. Porcelain-fused-to-metal vs. nonmetal crowns. J Am Dent Assoc 1999; 130: 409-11.
2. Blatz MB. Long-term clinical success of all-ceramic posterior restorations. Quintessence Int 2002;3:415-26.
3. Kilicarslan MA, Kedici PS, Kucukesmen HC, Uludag BC. In vitro fracture resistance of posterior metal-ceramic and all-ceramic inlayretained resin-bonded fixed partial dentures. J Prosthet Dent 2004;92: 365-70.
4. Piconi C, Maccauro G. Zirconia as a ceramic biomaterial. Biomaterials 1999;20:1-25.
5. Devigus A, Lombardi G. Shading Vita In-ceram YZ substructures: influence on value and chroma, part II. Int J Comput Dent 2004;7: 379-88.
6. Burke FJ, Fleming GJ, Nathanson D, Marquis PM. Are adhesive technologies needed to support ceramics? An assessment of the current evidence. J Adhes Dent 2002;4:7-22.
7. Rosenstiel SF, Land MF, Crispin BJ. Dental luting agents: a review of the current literature. J Prosthet Dent 1998;80:280-301.
8. Pallis K, Griggs JA and Woody RD: Fracture resistance of three all- ceramic restorative systems for posterior applications. J Prosthet Dent. 2004;91:561-9.
9. Potiket N, Chiche G and Finger IM: In vitro fracture strength of teeth restored with different all-ceramic crown systems. J Prosthet Dent. 2004;92:491-495.
10. Attia A, Abdelaziz KM, Freitag S and Kern M: Fracture load of composite resin and feldspathic all-ceramic CAD/CAM crowns. J Prosthet Dent. 2006;95: 117-23.
11. Fransson B, Oilo G, Gjeitanger R. The fit of metal ceramic crowns, a clinical study. Dent Mater 1985;1:197-199.
12. Nakamura T, DeiN, Kojima T. Marginal and internal fit of Cerec 3CAD/CAM all ceramic crowns. Int J Prosthodont 2003;16:244-248.
13. Schäfers F, Järschke J, Meyer G. Accuracy of fit of different all-ceramic procedures. *ZWR* 1994;103: 686–689.
14. C. F. J. Stappert, N. Denner, T. Gerds and J. R. Strub. Marginal adaptation of different types of allceramic partial coverage restorations after exposure to an artificial mouth. British Dental Journal Volume 199 No. 12 DEC 24 2005.
15. Gemalmaz D, Özcan M, Yoruc AB *et al*. Marginal adaptation of a sintered ceramic inlay system before and after cementation. *J Oral Rehabil* 1997;24: 646–651.
16. Lang R, Rosentritt M, Behr M, *et al*. The influence of modified glass ionomer cement, polyacid modified composite- and composite resin on the marginal accuracy of ceramic inlays. *Dtsch Zahnärztl Z* 2000; 55: 540–543.
17. Gemalmaz D, Ozcan M, Alkumru HN. A clinical evaluation of ceramic inlays bonded with different luting agents. *J Adhes Dent* 2001;3: 273–283.
18. McLean JW, Von Fraunhofer JA. The estimation of cement film thickness by an *in vivo* technique. *Br Dent J* 1971; 131: 107–111.

19. Lafuente JD, Chaves A, Carmiol R. Bond strength of dual-cured resin cements to human teeth. *J Esthet Dent* 2000; 12: 105–110.
20. Bjrn A-L, Bjrn H, Grkovic B. Marginal fit of restorations and its relation to periodontal bone level. Part II. Crowns. Odontol Revy 1970;21:337–346.
21. Sulaiman F, Chai J, Jameson LM, et al: A comparison of marginal fit of In-Ceram, IPS Empress, and Procera crowns. Int J Prosthodont 1997;10:478-484.
22. Xin-hua-Gu, Matthius Kern, Marginal Discrepancies and Leakage of All-Ceramic Crowns: Influence of Luting Agents and Aging Conditions, Int J Prosthodont 2003;16:109–116.
23. McComb D. Adhesive luting cements—Classes, criteria, and usage. Compend Contin Educ Dent 1996;17:759–762.
24. Beschnidt SM, Strub JR. Evaluation of the marginal accuracy of different all-ceramic crown systems after simulation in the artificial mouth. J Oral Rehabil 1999;26:582–593.
25. Mohamed F. Ayad, Effects of Tooth Preparation Burs and Luting Cement Types on the Marginal Fit of Extracoronal Restorations, Journal of Prosthodontics 18 (2009) 145–151.

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