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Comparative Evaluation Of Marginal Integrity Of Interim Crowns Fabricated With Two Different CAD/CAM Materials – An In Vitro Study.

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Abstract:
AIM: *The aim of this study is to Comparatively evaluate marginal integrity of interim crowns fabricated with two different CAD/CAM materials. The materials selected for this study are commercially available CAD/CAM based PMMA viz. VITA-CAD temp, Telio CAD.*
METHOD: *A dentoform molar was prepared for a ceramic crown and it was scanned for fabrication of 30 stereolithical resin dies and interim crowns. The 30 interim crowns were fabricated by two commercially available CAD/CAM materials (group A VITA CAD -15 samples, group B TELIO CAD -15 samples). After fabrication of interim crowns cementation was done. Later sectioning of crowns was performed to evaluate marginal integrity of the interim crowns manufactured by two different CAD/CAM materials.*
RESULTS: *Group A (VITA-CAD) had higher marginal gap/ discrepancy as compared to Group B (TELIO-CAD).*
CONCLUSION: *The marginal gap size of TELIO-CAD was found to be lesser than VITA-CAD.*
KEY WORDS: *CAD/CAM, provisional restoration, marginal integrity, marginal fit.*

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I. Introduction

Fixed Prosthodontics is the branch of Prosthodontics concerned with the replacement and/or restoration of teeth by artificial substitutes that cannot be removed from the mouth by the patient.[1] Fixed Prosthodontic treatment, whether involving complete or partial coverage and natural tooth or dental implant abutments, commonly relies on indirect fabrication of definitive prostheses in the dental laboratory. Historically, the necessity for provisional treatment has been primarily derived from this methodologic process.[2]

A provisional prosthesis is defined as "a fixed or removable prosthesis, designed to enhance esthetics, stabilization or function for a limited period of time, after which it is to be replaced by a definitive prosthesis".[3] Prosthodontic treatment is often incomplete without accurate provisional or interim restorations. The need for provisional restorations has its roots in esthetic, diagnostic and physiologic factors.[3]

Accurate provisional restorations are essential and serve a number of functions including protection of the pulpal tissues, bacterial contamination, and preservation of periodontal tissues. In addition, preventing rotation of the tooth from its normal position in terms of supra or infra occlusion, maintaining esthetics and oral functions, such as mastication and speech, is paramount.[4]

The need for accurate provisional restorations has led to the introduction of a multitude of materials for the same, with considerable variation in physical, chemical and biologic properties. As newer materials enter the clinical arena, a thorough understanding of each is imperative to maximize the benefits in any given restorative scenario.[3]

The most common materials used for the fabrication of the provisionals are polymethylmethacrylate (PMMA) resins.[5] Autopolymerizing PMMA resins have several deficiencies. Previous studies have reported polymerization shrinkage and marginal discrepancies with these materials. The danger of pulpal damage because of exothermic reaction of polymerization has been equally well documented, as has sensitivity of the periodontium to the contour and fit of provisional restorations. However, these problems are associated primarily with direct methods of fabrication. It is beneficial to fabricate provisional restorations indirectly on casts made from impressions of prepared teeth. The indirect technique has been associated with superior fit and pulpal protection.[6]

Innovative materials, such as high-density polymers based on a highly cross-linked polymethyl methacrylate (PMMA) or composite resin for Computer-Aided Design/Computer Aided-Manufacturing (CAD/CAM), have gained interest.[7]

Computer-aided design/computer aided manufacturing (CAD/CAM) is increasingly used to fabricate prosthetic restorations as it reduces laboratory time and material costs while increasing productivity.[8]

The marginal fit or accuracy of a restoration can be defined best in terms of the "misfit" or the gap measured at various points between the restoration and the tooth.[5] Marginal fit is an important predictor of the clinical success and longevity of dental restorations. A restoration with poor marginal fit can damage the tooth, periodontal tissue, and even the restoration.[9] The marginal fit of provisional crown varies with different techniques, materials, and conditions used for fabrication. Provisional crown margin made by indirect technique was considered to be more accurate than that made by the direct technique.[10]

The importance of the provisional (treatment) restoration among the procedures required for successful completion of a fixed partial denture is often overlooked.[11] A well-made provisional fixed partial denture should provide a preview of the future prosthesis and enhance the health of the abutments and periodontium.[12]

However, limited clinical evidence in terms of marginal fit/ marginal integrity is available for CAD/CAM provisional restorations fabricated with newer generation of crown and bridge resins. Hence, this study is planned to comparatively evaluate the marginal fit / marginal integrity of interim crowns made using commercially available newer generation of CAD/CAM provisional restorative materials.

II. Aim And Objectives

The aim of this study is to Comparatively evaluate marginal integrity of interim crowns fabricated with two different CAD/CAM materials. The materials selected for this study are commercially available CAD/CAM based PMMA viz. VITA-CAD temp, Telio CAD.

III. Materials And Methodology

Ethical committee approval and study design -

This study was carried out in the Department of Prosthodontics in 2019–2020. Ethics was granted by the Institutional Ethical Committee and research board approval. The study conducted according to the ethical standards given in the 1964 Declaration of Helsinki, as revised in 2013.

The sample size was calculated using the references of related articles, studies, reviews and sample size formula. The power of the study is less; thus, the sample size was taken as 30. The sample was divided into two groups, namely Group A and B. Each group was assigned 15 samples each.

Fabrication of samples-

Samples were made with two different provisional materials (VITA-CAD temp and Telio CAD) as mentioned above to compare the marginal integrity of interim crowns.

• VITA-CAD temp (**VITA Zahnfabrik, India**): micro filler reinforced polyacrylic. Group A - 15 samples. (fig. 1)

• Telio CAD (Ivoclar Vivadent Marketing (India) Pvt. Ltd.): cross-linked PMMA blocks. Group B - 15 samples. (fig. 2)

Fig. 1. VITA CAD temp (group A) provisional material

Fig. 2. TELIO CAD (group B) provisional material

Fabrication of die model-

A dentoform right first mandibular molar will be prepared for a ceramic crown. (fig. 3) The prepared tooth will be scanned to fabricate 30 stereolithical resin dies and provisional crowns. (fig. 4 & fig. 5)

Fig. 3. Prepared tooth for ceramic crown

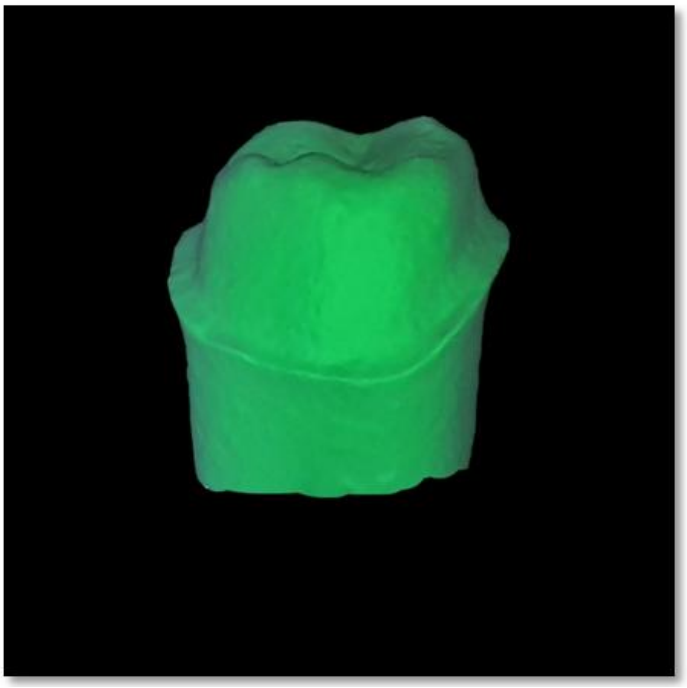


Fig. 4. Scanning of prepared tooth

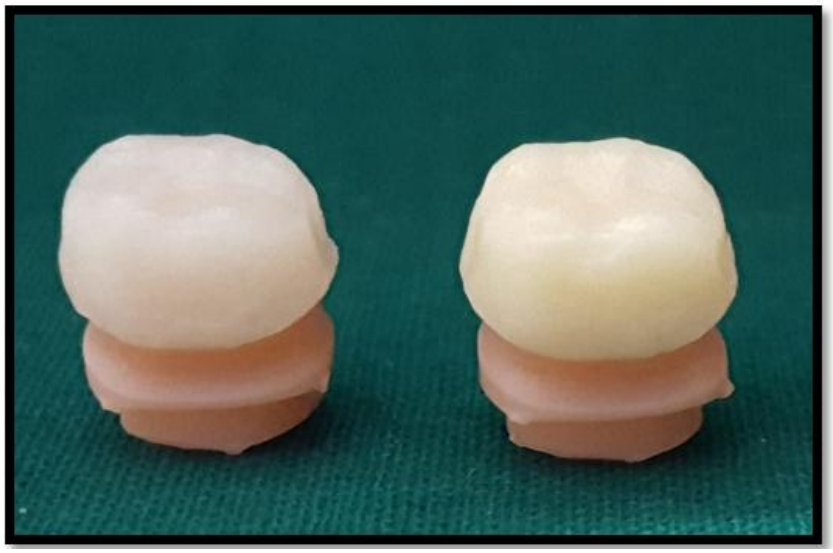


Fig. 5. Stereolithical resin dies and provisional crowns

Computer-Assisted Designing and Computer-Assisted Milling specimens –

In this study, VITA-CAD temp (**VITA Zahnfabrik, India**) AND Telio CAD (Ivoclar Vivadent Marketing (India) Pvt. Ltd.) PMMA resin blanks were used to fabricate specimens for group A and group B respectively. The Die model with prepared tooth was scanned with extraoral scanner and virtual image were obtained. Design of prosthesis was done on obtained virtual image. The computer file in STL format was transferred to CAD program, and the specimens were transferred to the milling unit. The specimens were milled in pre polymerized PMMA blanks (VITA CAD, Telio CAD) of the shade A2. Conventional cutters, trimmers were used for finishing and polishing within the milling machine.

PROCEDURE OF STUDY

A dentoform right first mandibular molar will be prepared for a ceramic crown. The prepared tooth will be scanned to fabricate 30 stereolithical resin dies and interim crowns. 30 interim crowns will be fabricated by VITA-CAD Temp (group A - 15) and Telio CAD (group B - 15) CAD/CAM materials. The interim crowns will be cemented on resin dies with help of temporary luting cement. The cemented crowns will be thermocycled to replicate ten weeks intraoral environment, after which the samples will be immersed in 0.5% acid fuschin for 24

hours to evaluate microleakage. Dies later will be embedded in resin to prevent dislodging while sectioning the samples. (fig. 6) The dies will be sectioned from mid-buccal to mid-lingual and mid-mesial to mid-distal sections. (fig. 7)

Fig. 6. Die embedded in acrylic resin.

Fig. 7. Sectioning of samples embedded in acrylic resin

Marginal fit: Marginal fit will be measured with stereomicroscope. (fig. 8 & fig. 9) Measurements will be made at all the four margins by measuring vertical and horizontal marginal fit. The vertical marginal fit will be calculated by measuring void from the base of the provisional crown to the surface of the die in long axis of the tooth. The horizontal marginal fit will be calculated by measuring base of vertical edge of crown to the edge of the die.

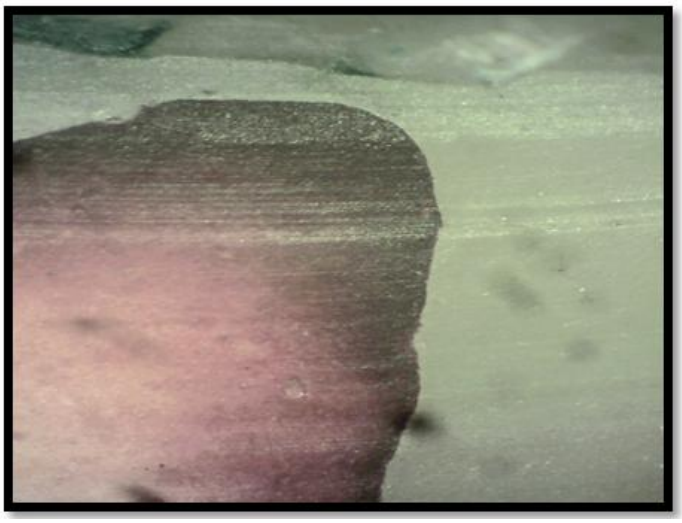


Fig. 8. Measuring marginal fit of VITA CAD temp (group A) PMMA provisional material under stereomicroscope.

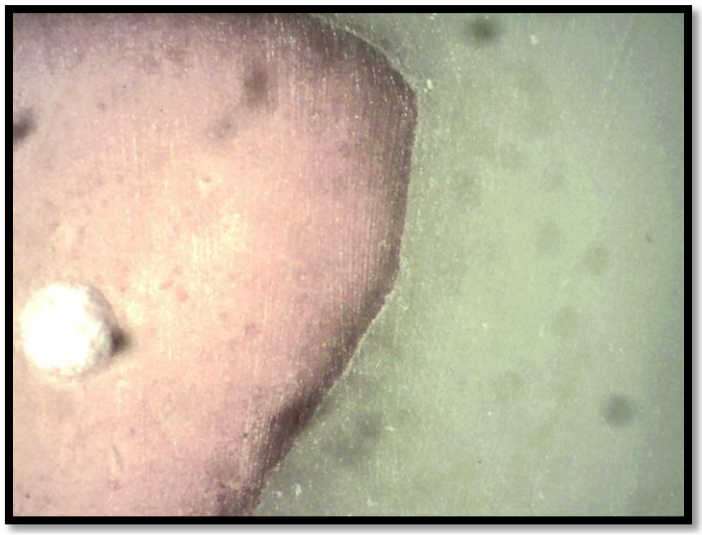


Fig. 9. Measuring marginal fit of TELIO CAD (group B) PMMA provisional material under stereomicroscope.

IV. Data Analysis

Statistical analysis will be performed using Statistical Product and service solution (SPSS) version 16 for Windows (SPCC Inc, Chicago, IL). Descriptive quantitative data will be expressed in mean and standard deviation respectively. Data normality will be checked by Shapiro-Wilk Test. Inter group comparison of means between two groups of different commercially available PMMA based CAD/CAM provisional restorative materials will be done using ONE WAY ANOVA TEST and TUKEY'S POST HOC TEST. Confidence interval is set at 95% and probability of alpha error set at 5% Power of study set at 80%.

V. Results

The marginal integrity was recorded for each specimen. This raw data of the values obtained were compiled on MS- Excel sheet to get the mean and SD. The data were then statistically analyzed.

Mean values and standard deviations (M±SD) of the marginal gap for both groups are graphically shown in Figure. (table. 1 & table. 2) The average marginal gap for each group was: VITA CAD-Temp (59.67 µm) and TELIO CAD (49.64 µm). On comparative statistics of marginal gap/discrepancy between Group A (VITA-CAD) and Group B (TELIO-CAD) respectively, there was found to be statistical significant difference ($p<0.001$) between both groups where Group A (VITA-CAD) had higher marginal gap/ discrepancy as compared to Group B (TELIO-CAD).

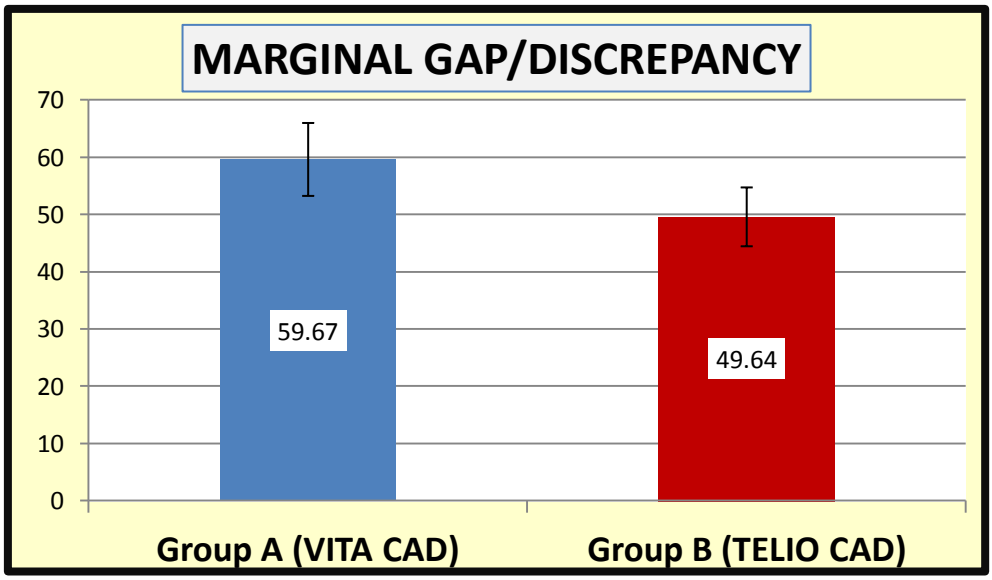
	Mean (µm)	SD	S.E	Minimum (µm)	Maximum (µm)
Group A (VITA-CAD)	59.67	6.37	2.01	51.04	67.93
Group B (TELIO-CAD)	49.64	5.14	1.62	41.09	56.93

Table 1: Descriptive statistics of marginal gap/discrepancy in Group A (VITA-CAD) and Group B (TELIO-CAD) respectively

On comparative statistics of marginal gap/discrepancy between Group A (VITA-CAD) and Group B (TELIO-CAD) respectively, there was found to be statistical significant difference ($p<0.001$) between both groups where Group A (VITA-CAD) had higher marginal gap/ discrepancy as compared to Group B (TELIO-CAD)

	MEAN (µm)	SD	Unpaired t test	p value, Significance
GROUP A (VITA-CAD)	59.67	6.37	t= 3.872	p =0.001*
GROUP B (TELIO-CAD)	49.64	5.14		

Table 2: Comparative statistics of marginal gap/discrepancy between Group A (VITA-CAD) and Group B (TELIO-CAD) respectively



Graph. 1. Comparison of marginal fit of VITA CAD (group A) and TELIO CAD (group B)

VI. Discussion

The purpose of this study was to investigate the difference in performance of interim crowns that were fabricated by sophisticated indirect CAD/CAM approach. The importance of precise interim restorations is generally accepted in order for the definitive restoration to function properly. In addition, there is certain evidence that the CAD/CAM provisional restorations may be superior to the conventional provisional restorations.[4]

Interim CAD/CAM restorations promises a certainly easier method of fabrication for the clinician and also provides potentially stronger provisional restoration. However, these CAD/CAM interim restorations comprises a more expensive alternative to conventional directly made provisional restorations.

A restoration is regarded successful when it exhibits a good marginal fit and is strong enough to withstand the oral environment. Marginal integrity is critical in provisional restoration since poor marginal integrity can lead to inflammation of periodontal tissue which can lead to improper fit of the definitive prosthesis.

Adil Abdullah et al compared and evaluated marginal fit of CAD/CAM provisional restorations and he found similar results in his study. He found statistical difference between TELIO-CAD (56.10 µm) and VITA-CAD (60.61 µm) where TELIO-CAD had lower marginal gap as compared to VITA-CAD.[4]

Jiajing Yao also compared the marginal accuracy of the CAD/CAM and conventional provisional restorations and found that CAD/CAM provisional restorations showed better results. The CAD/CAM interim materials were more stable, not only demonstrating greater initial marginal accuracy but also resisting hot, cold, and moist environments. CAD/CAM interim materials are better suited for interim treatments, especially long-term treatments such as those for final prosthetic therapy.[13]

The importance of accurate and well made provisional restorations in prosthodontic treatment cannot be emphasized enough. This article has reviewed the commercially available CAD/CAM materials used for fabrication of interim restorations, with the goal of familiarizing the clinician with the properties of the materials. The plethora of materials available today requires the clinician to have an in depth understanding of each in order to maximize the benefits and fit the requirements in any given clinical scenario.[3] As no single material exists that fits all the requirements, research should be further initiated towards the quest for the ideal material in terms of satisfying each need of both the patient and the doctor.

VII. Conclusion

Within the limits of this *In Vitro* study, the following conclusions can be drawn:

- The marginal gap size of TELIO-CAD was found to be lesser than VITA-CAD.
- As both the materials (TELIO-CAD & VITA-CAD) showed values under significant range hence, can be used for long term temporaries.

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