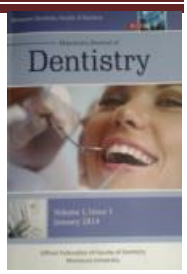

Marginal and Internal Adaptation of Occlusal Veneer Restorations: Effect of Material Type and Bonded Substrate

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Abstract:
Objective: To evaluate the effect of material type and bonded substrate on the marginal and internal adaptation of occlusal veneer restorations**.**
Materials and methods: Ninety intact human mandibular molars were selected for this study, divided into three groups (N= 30) depending on three different martials of lithium disilicate ceramic (L), zirconia (Z) and hybrid ceramics (H) with the thickness of 1.0 mm. Each test groups divided into three subgroups (N=10) depending on the bonded substrate, subgroups (LD, LC and LF), subgroups (ZD, ZC and ZF) and subgroups (HD, HC and HF). Before cementation, discrepancies were measured at the margin (µm) of each occlusal veneer. Silicone replicas were obtained to measure marginal and internal discrepancies (µm) that was evaluated with stereomicroscope at 35X magnification. All occlusal veneers were cemented to their corresponding abutments using adhesive resin cement. After 24 hours water storage and thermocycling for 5000 cycles at 55-5 °C, specimens were subjected to dynamic loading in a chewing simulator with 120.000 loading cycles. Then marginal discrepancies (µm) were evaluated after final cementation. The data were statistically analysed using Wilcoxon signed Rank test and three-way ANOVA test was used for detection of effect of material type and bonded substrate on dependant outcome.
Results: After cementation, significantly higher marginal discrepancies were notes in comparison with before cementation. Restorative materials significantly affected on the marginal and internal adaptation.
Conclusions: Occlusal veneer bonded to dentin with filling composite showed better marginal and internal adaptation than bonded to dentin with prepared cavity and bonded to dentin. Hybrid ceramic restoration provided superior marginal and internal adaptation than zirconia and lithium disilicate restoration.
Key words: Occlusal veneers, CAD/CAM, ceramic materials, marginal and internal adaptation.

Introduction

Ultiple full-coverage restorations, crown lengthening, and elective tooth devitalization can be used to treat badly worn dentition.[1]To fit the preparation design, these procedures typically necessitate the removal of healthy tooth tissues. Adhesive principles were used to preset a conservative approach to restoring tooth surface loss using direct resin composite restorations.[2] Erosion, bruxism, or a combination of these factors are the most common causes of severe tooth wear, which results in a loss of occlusal vertical dimension. An increase in this occlusal vertical dimension is needed to obtain adequate room for restoring worn down teeth.[3]Attrition refers to the wearing away of dental tissue as a result of teeth contact during natural or parafunctional operation.[4]Often, certain orthodontic outcomes may be impossible to obtain without briefly raising the vertical dimension: this may be the case when repairing severe arch or occlusal plane issues, such as in patients with lateral open bite following orthodontic treatment.[5]

Total coverage that isn't retentive Occlusal veneers are a common treatment choice for restoring the shape and morphology of posterior teeth that have been worn down by occlusal wear and/or advanced erosive lesions. Since further tooth preparation will result in the loss of a significant amount of dental tissue due to wear and erosion, minimally invasive designs or the "no-preparation" solution have been proposed for teeth where a significant amount of dental tissue has already been lost due to wear and erosion.[6] In prosthodontics, CAD/CAM is commonly used.[7]Most products are now completely manufactured in industrial settings, maintaining quality levels that are difficult to attain in laboratory settings.[8] Because of its precise quaility, the industrial environment of CAD/CAM fabrication greatly reduces the likelihood of defects or flaws, and it supports testing of the mechanical strength of the manufactured blocks.[9]

The aim of this in-vitro study was to evaluate the effect of material type and bonded substrate on the marginal and internal adaptation of occlusal veneer restorations.The null hypothesis of this study was that, the marginal and internal gap measurements did not affect either by preparation design, bonded to substrate or ceramic materials. The materials type as well as the preparation design did not influence on the marginal and internal adaptation of the occlusal veneers.

Materials and Methods

90 intact human mandibular first molars with homogeneous measurements and morphology, freshly extracted for periodontal purposes, were collected. The teeth were then disinfected for one week with 1:10 diluted 5.25 percent sodium hypochlorite household bleach. After that, the teeth were held in a 0.9 percent standardized saline solution at

room temperature during the testing duration to prevent dehydration.[10]

Ninety intact human mandibular molars were selected for this study, divided into three groups (N= 30) depending on three different martials of lithium disilicate ceramic (L), zirconia (Z) and hybrid ceramics (H) with the thickness of 1.0 mm. Each test groups divided into three subgroups (N=10) depending on the bonded substrate, subgroups (LD, LC and LF), subgroups (ZD, ZC and ZF) and subgroups (HD, HC and HF).

The occlusal reduction for three groups was set at 1 mm, following the indications about the minimum occlusal thickness for the final restoration given by the manufacturer of the matrials used in the present stud, lithium disilicate CAD/CAM blocks.zirconia blank and hybrid ceramic.

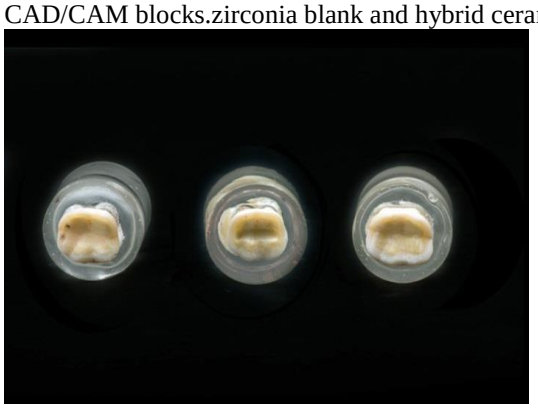

Figure 1. Preparation of three designs

Restorations design and fabrication

90 occlusal veneers were scanned using Identica blue scanner. Each occlusal veneer was designed to rebuild its corresponding tooth. An internal relief spacer of 50 micron was used in all designs for standardization. The design data in the form of STL file was sent toimes-icor TEC 250i milling machine unit. After milling, the veneers were cut from sprues, and the connection sites were smoothed. For the lithium disilicate and zirconia occlusa veneers, they were subjected to crystallization and glazing firing cycles.Each veneer was then checked for seating on its corresponding tooth.

Measurement of internal fit of occlusal veneer before cementation:

The internal adaptation was evaluated by measuring the thickness of the light polyvinyl siloxane material, using stereo microscope (Olympus SZ61, Tokyo, Japan)with 35X magnificationcombined with microscopic camera (TUCSEN, H Series, China) and image processing software (TCapture 5.1, TUCSEN, China).[11] For each specimen, marginal gaps (MG) were measured at mesial, diatal, buccal and lingual. Internal gaps (IG) at six different points were measured from mesio-distal section and six different points from bucco-lingual section of the replicas**(Figure 2).**

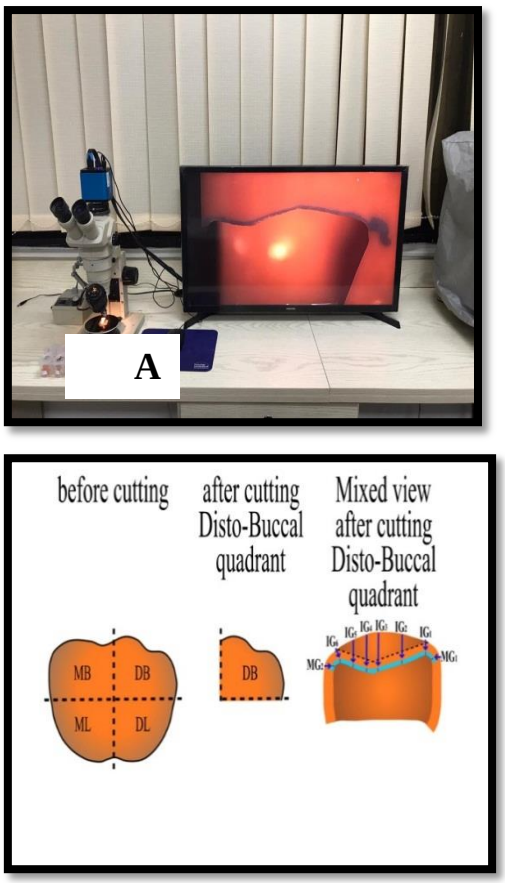

Figure 2. A) Stereomicroscope combined with microscopic camera and image processing software
B)Showing schematic points of marginal gaps and internal gaps

Cementation of occlusal veneer

Following the manufacturer's instructions, the occlusal veneers were etched with 9.5% hydrofluoric acid for 20 seconds for lithium disilcateveneers and 60 seconds for hybrid ceramic veneers then rinsed off with forceful water spray for 30 seconds. The silane coupling agent was applied and dried gently for 5 seconds. While the fitting surfaces of all zirconia restorations were abraded with airborne 50 µm aluminum oxide particles. After that, the fitting surfaces of all zirconia restorations were treated with primer for 10 seconds then; it was carefully blowed with a light stream of air for 5 seconds according to manufactures instruction. The phosphoric acid at 37% was applied on prepared tooth for 20 seconds and rinsed under running water for 15 seconds and gentle air dryness. After the assurance of white chalky appearance of tooth enamel border, two coat of the light-cured bonding agent were applied into the conditioned tooth substance for 5 seconds, then light polymerized for 10 seconds according to manufacturer's instructions. The adhesive system BISCO dual cure adhesive resin cement was applied on the inner surface of occlusal veneer, which was immediately placed on the preparation, followed by 250 g-load using a cementing loading device.[12]After removing excess cement, each face of the occlusal veneer was curing for 60 seconds.

After 24 hours water storage and thermal cycling for 5000 cycles[13] at 55-5 c, specimens were subjected to dynamic loading in a chewing simulator with 120.000 loading cycles.[14] To mimic the thermalcycling fatigue that occurs in the oral cavity.Finally, the data obtained was collected, tabulated and then subjected to statistical analysis.

Results of this study

The statistical analysis of (LD, ZD, and HD) (LC, ZC, and HC) (LF, ZF, and HF) values of tested groups were showed in **Table 1, 2, 3**. One-way ANOVA test was used to compare effect of (LD, ZD, and HD) (LC, ZC, and HC) (LF, ZF, and HF) on marginal and internal adaptation (µm) with replica technique.

Table 1: Comparison of marginal and internal adaptation (replica technique) of (LD, ZD and HD).

	LD	ZD	HD	test of significance
Marginaladaptation (µm)	109.21±8.17^{AB}	93.32 ± 8.88^{AC}	86.25±7.87^{BC}	F=21.27 P<0.001*
Internal adaptation (µm)	131.22±4.99^{AC}	115.19±5.85^{AB}	80.74±7.22^{BC}	F=240.53 P<0.001*

Table 2: Comparison of marginal and internal adaptation (replica technique) of (LC, ZC and HC)

	LC	ZC	HC	test of significance
Marginaladaptation (µm)	122.08±10.07^{AB}	99.93±12.36^{AC}	88.58±7.21^{BC}	F=77.88 P<0.001*
Internal adaptation (µm)	139.69±3.97^{AB}	115.68±9.97^{AC}	82.85±8.27^{BC}	F=363.002 P<0.001*

Table 3: Comparison of marginal and internal adaptation (replica technique) of (LF, ZF, and HF).

	LF	ZF	HF	test of significance
Marginaladaptation (µm)	98.84±2.98^{AB}	88.45±8.03^{A}	84.37±12.64^{B}	F=20.03 P<0.001*
Internal adaptation (µm)	125.45±2.94^{AB}	99.69±11.07^{AC}	77.95±10.78^{BC}	F=33.81 P<0.001*

Discussion:-

The current in vitro study was done to evaluate the marginal and internal gap distance of occlusal veneer restorations with three preparation designs that were fabricated from lithium disilicate glass ceramic, zirconia and hybrid ceramic material using CAD/CAM technology. Marginal and internal adaptation in this study was identified by the replica technique.

The null hypothesis of the present study that would be no difference in marginal and internal adaptation between the three designs or ceramic material was rejected according to the statistical analysis of the obtained data, which revealed that there was a significant difference in marginal and internal adaptation of three designs as well as of the three tested ceramic materials.

Recent developments of restorative materials, technology of construction techniques, and advanced adhesive approaches have encouraged the fixed prosthodontics towards more conservative plans of treatment.[6]Occlusal veneers have been demonstrated as a conservative alternative to traditional onlays and complete coverage crowns for the treatment of severe abrasive/erosive lesions.[5] However, **Schlichting 2011 et al**[6]reported that the best restorative material is yet to be known. They considered that only bonded ceramics and composite resins address the biomimetic principles of conservation and esthetics.

In current study all occlusal veneers were fabricated using CAD/CAM which gives the ability to control reduction thickness and anatomy of restorations during the fabrication process. It also allowed the standardization of the marginal and internal fit of the restoration.Many potentially confounding operator variables were avoided such as dental laboratory technician's skills and procedures involved in the fabrication process.[16]A spacer thickness was set to be 50 µm which was recommended by **Souzaet al2012**[17]who evaluated marginal and internal discrepancies related to margin design of ceramic crowns fabricated by a CAD/CAM system and found that consensus on acceptable marginal adaptation-discrepancy established a range from 50 to 150 µm. On the other hand, keeping the cement thickness as minimal as possible helps to enhance achieving the accurate insertion of the prosthetic component and to allow interposition of a uniform layer of the cement with mean values 25 to 50 µm.[18]

Regarding results of marginal and internal fit of constructed occlusal veneers restorations that measured by replica technique (µm) was statistical significant higher mean marginal adaptation among groups with LC than LD and the least was detected for LF. While mean internal adaptation was highest for LC than LD and the least was detected for LF. There is statistical significant higher mean marginal adaptation among ZC than ZD and the least was detected for ZF. Similarly, mean internal adaptation was highest for ZC than ZD and the least was detected for ZF.

There is no statistical significant difference in mean marginal adaptation among HC than HD and the least was detected for HF Similarly, internal adaptation have no statistical significant difference among groups with mean marginal adaptation for HC, HD and the least was detected for HF.So The results obtained from this study found that the LD, LC and LF groups recorded statistically significant highest marginal and internal gap mean value than (ZD, ZC and ZF) and (HD, HC and HF).

Conclusions

Within the limitations of this study, the following can be concluded

1) Preparation bonded to dentin with filling composite showed better marginal and internal adaptation than bonded to dentin with prepared cavity and bonded to dentin.
2) Hybrid ceramic restoration provided superior marginal and internal adaptation than zirconia and lithium disilicate restoration.

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