Original Article

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MARGINAL FIT AND MICROLEAKAGE OF HYBRID CERAMIC CROWNS FABRICATED USING TWO CAD/CAM SYSTEMS: A LABORATORY STUDY

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ABSTRACT:

Purpose: Evaluation of the marginal fit and microleakage of crowns fabricated from hybrid ceramic using two CAD/CAM (Computer aided design computer aided manufacturing) systems of two different scanning technique.

Materials and methods: Fourteen teeth were selected and divided according to CAD/CAM systems used into 2 main groups (n=7); (S) group was fabricated using SHERA CAD/CAM and (C) group using Ceramill motion 2 CAD/CAM. Crowns were fabricated from hybrid ceramic (Vita Enamic, Vita zahnfabric, Germany). After cementation, all the Specimens were stored in water for 24 hours, thermocycled and immersed in a methylene blue dye (2%) for 12 hours. All of the specimens were sectioned bucco-lingually by precision cutting machine. Marginal fit and micro-leakage were examined using a stereomicroscope.

Results: There was a significant difference in the vertical marginal gap and microleakage between the two groups. The vertical marginal gap of crowns fabricated by SHERA and Ceramill motion 2 CAD/CAM systems were (33.43±7.49) and (54.79±7.76) respectively.

The microleakage of crowns fabricated by SHERA and Ceramill motion 2 CAD/CAM systems were (205.93±31.45) and (322.71±23.27) respectively.

Conclusions: Under the conditions of this study the SHERA CAD/CAM system could fabricate crowns with better marginal fit than Ceramill motion 2.

Clinical Significance: The type of CAD/CAM scanning technique highly affects the marginal fit of hybrid ceramic crowns.

Keywords: CAD/CAM, Scanning technique, hybrid ceramic, streomicroscope.

INTRODUCTION:

Success of a dental restoration is determined mainly by three main factors esthetic value, resistance to fracture, and marginal adaptation.[1] While most clinical trials for all-ceramic crowns have reported a survival rate of greater than 90% irrespective of the observation period and materials used.[2] With the revolutionary use of all-ceramic crowns, all ceramic systems have become a viable treatment option. These newer materials also are resistant to wear like enamel and have satisfactory strength to be used as full crowns and bridges That's why the use of CAD/CAM technology in dentistry allowed innovative, state-of-art dental service and contributed to improve the health and the quality of life.[3]

According to the manufacturer recommendation, Vita Enamic can be used for posterior restorations

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particularly where only a little space is available and less invasive restorations is needed. This material has high strength, perfect margin adaptation after milling which allows accurate fit restorations, less wear of milling tools, superior milling, and helps to make less tooth reduction.[4]

The first produced computer-assisted dental restoration was introduced in 1971. Unlike the conventional impression, CAD technology utilize another technique for data acquisition (digitizing). At the beginning the capturing was performed only intraoral but today the data collection can be made direct in the patient’s mouth using intraoral scanner or indirect from cast or impression using extraoral scanner.[5] The collected data is formed of data spatial coordinate of points from the scanned tooth. Scanning step is mandatory for any CAD/CAM methodology and requires the utilization of hardware and software which are not the same for the different systems; the number of cameras, scan accuracy, light technology, speed of scanning and many other features may differ.[6]

Scanners are divided into intraoral scanner and extraoral scanner. Using the intraoral scanner, a digital impression making is accomplished by capturing data directly from the patient mouth with neglecting the conventional impression and model making steps.[7]As for extra oral scanner scanning process was made by scanning the working cast which is done using contact or non-contact scanner. With non-contact scanner, surface digitization is done by projecting white light or laser on the object to be scanned, and a digital camera which acts as the receptor unit register the reflected patterns. That`s why a definite angle represents the relationship between the source of light and the receptor unit. The manufacturer explained this technology as emitted and reflected rays travel their pathway in the same line. Which permits capturing of steep slopes of up to 85°.After the reflected light or laser reach the camera, triangulation is used to calculate a 3D data through software using.[8] For intraoral and extraoral methods of scanning a 3D image of the virtual model is projected on the monitor so the clinician becomes able to rotate it for viewing from any angle. New software allow the crown form to be designed by choosing the suitable tooth from system library and then adjusting the restoration to be compatible with the neighboring and opposing teeth.[3]

Up to the knowledge of the authors there is a little number of studies that discussed the effect of different scanning techniques on the marginal fit of ceramic crowns. So the aim of this study was to assess the marginal fit and microleakage of hybrid ceramic crowns manufactured using SHERA with laser scanner and Ceramill motion 2 with light scanner. The null hypothesis was that there wouldn’t be a difference between the marginal gap and microleakage of the hybrid ceramic crowns fabricated using the two different CAD/CAM systems.

MATERIALS AND METHODS:

2.1. Teeth collection

Twenty eight sound human maxillary premolars extracted for orthodontic treatment with mesio-distal diameter range (7-8 mm), the selected teeth are free of caries or cracks, they were cleaned using a brush and an ultra-sonic scaler and any soft tissue was removed from the teeth. Teeth were centralized in epoxy resin blocks till the height of 2 mm below the cemento-enamel junction **(Figure: 1)**.

2.2. Preparation and ceramic material

All the teeth were prepared for all ceramic restorations with occlusal reduction (2mm for the functional cusp and 1.5 mm for the non-functional cusp) and a heavy chamfer finish line (1mm), A straight handpiece fixed to a surveyor (DentalFarm, Italy*)* was used for teeth preparation to allow preparing axial walls of all the teeth with 6 degrees tapering **(Figure: 2)**.

2.3. Crowns fabrication

Vita Enamic crowns were milled using two types of CAD/CAM systems SHERA system (SHERA WERKSTOFF TECHNOLOGIE, Germany*)* with laser scanner and Ceramill motion 2 system (Amann Girrbach, Germany) with light scanner. Each system work through a chain of steps consisting of scanning, designing and milling. To achieve standardization, parameters of both systems were adjusted to be the same; cement space was adjusted to 50 µm.

2.4. Cementation

All the crowns were cemented with Bisco DUO-LINK UNIVERSAL resin cement under a constant static load for five minutes (5 kg) using a special device.

2.5. Accelerated artificial aging

After cementation the specimens were stored in distilled water for 24h then received thermo-cycling (10000 cycle which is equivalent to 3 years in the oral cavity)[10] by altering between 5° c and 55° c with a dwell time 30 seconds using (Mechatronic Thermocycler THE-1100, Germany) **(Figure: 3)**. After thermal cycling was completed, all the teeth were coated with two layers of nail varnish except for 1 mm around the crown margins.

2.6. Specimens sectioning

Each tooth was sectioned centrally bucco-lingually using metal cutting disk, (Isomet 4000 linear microsaw, buehler, Germany) Followed by teeth examination at the buccal margin and the lingual margin under a stereomicroscope (Stereoscopic Zoom Microscope, Nikon Corporation, Japan) connected to a digital camera (Digital sight Camera, Nikon, Japan) which was adjusted to make 40x magnification **(Figure: 4)**. Marginal gap was evaluated by measuring the perpendicular line from the most cervical external edge of the restoration to the most outer edge of the finish line of the preparation which is the vertical marginal gap. Microleakage was measured by the extent to which the dye penetrates between the prepared wall of the tooth and the inner surface of the restoration **(Figure: 5)**.

RESULTS:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0*.* Quantitative data were described using mean, standard deviation for parametric data. Student-t test was used to compare the vertical marginal gap and the microleakage of the two groups S & C. There was high significant difference between the marginal gap of the crowns fabricated by the two CAD/CAM systems ($p<0.001$). The vertical marginal gap of Vita Enamic crowns fabricated by SHERA and Ceramill motion 2 CAD/CAM systems were (33.43±7.49) and (54.79±7.76) respectively (**Table: 1).**

The microleakage of Vita Enamic crowns fabricated by SHERA and Ceramill motion 2 CAD/CAM systems were (205.93±31.45) and (322.71±23.27) respectively (**Table: 2).**

DISCUSSION:

The present study assessed the marginal fit of hybrid ceramic crowns (Vita Enamic) using SHERA CAD/CAM system with laser scanner and Ceramill motion 2 CAD/CAM system with light scanner aiming at determining whether the type of the CAD/CAM scanner could influence the marginal fit of the restoration. Since the marginal fit was found to be the most critical factor determining the accuracy of the recently introduced CAD/CAM systems[10], marginal discrepancy of crowns fabricated using the two systems was evaluated. Results show that there was a significant difference between the mean marginal gap values of crowns fabricated by SHERA CAD/CAM and Ceramill motion 2 CAD/CAM. Thus the suggested null hypothesis was rejected.

The marginal gap was measured perpendicularly from inner surface of the crown to the edge of the tooth finish line which is known as the vertical marginal gap which was found the most critical factor of marginal gap while being the least susceptible to manipulation post-fabrication. Horizontal discrepancies, such as crown overextension, are adjustable to some degree intra-orally, however, vertical marginal gap can only be sealed by cement, which is susceptible to dissolution. That's why, the vertical marginal gap gives the most reliable values and should be considered as the most critical in crown margin assessment.[11]

The results of this study are in agreement with Alqahtani F, (2017).[12] who evaluated marginal accuracy of all-ceramic restoration manufactured using two extraoral CAD/CAM systems (Cerec and Trios) and compared them with crowns fabricated by the ordinary lost-wax method. There was a statistical significant difference in the marginal gap of lost wax and CAD/CAM manufactured restorations. The result assure that the manufacturing method has a noticed influence on the marginal fit of the crowns. Trios CAD (with laser scanner) and Wieland CAM show the least mean, followed by the conventional method, whereas the highest marginal gap came from the Cerec group (with light scanner). On the other hand, some researchers studied the marginal fit of crowns manufactured using the Lava COS (laser scanner), Cerec (light scanner), and iTero (laser scanner) scanning systems, the marginal fitness of all three has been the same.[13]

Prudente M et al, (2018) [14] compared two different intra oral scanners and assessed the effect of using internal adjustment of the fabricated crowns, vertical fit and horizontal fit were influenced by the use of different intraoral optical scanner technologies and the crowns subjected to intaglio surface adjustment showed better marginal fit.

Majeed M and Al-Adel S, (2016).[15] compared Full contoured CAD/CAM restorations made using Vita Enamic, zirconia, lithium disilicate and zirconia-reinforced lithium silicate, thus Vita Enamic crowns show better marginal and internal accuracy than other materials, followed by zirconia crowns, while crowns made of lithium disilicat and zirconia-reinforced lithium silicat show the least marginal and internal fit with no statistically significant difference among them. For all tested groups, the marginal gap was less than internal gap, with a positive correlation between the marginal and the internal gap. This may give an indication clinically that any crown restoration with poor marginal adaptation will also exhibit inaccurate internal adaptation. They found also that the marginal gap and of hybrid dental ceramic crowns were within the clinically acceptable range which coincides with results of this study.

The major drawbacks of comparing the results of different studies include the absence of a standardized methodology and that many factors can influence the results. One of these factors is the different measurement methodologies used. Although various protocols have been proposed to analyze marginal precision, no guidelines exist regarding how to perform gap measurements therefore, variability exists in the results obtained from the different techniques used to record the data.[16]

CONCLUSION:

On the basis of the results and conditions of this study, the following conclusions can be drawn:

1) Different CAD/CAM systems with different scanning technique have a significant effect on the marginal fit and microleakage of the different ceramic crowns.

2) Marginal gap of crowns fabricated using the two CAD/CAM systems are within the acceptable range (<100 um).

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TABLES:

Table (1) Comparison of vertical marginal gap between S & C

	S		C		t	P
	Mean	±SD	Mean	±SD		
Buccal	32.86	10.48	56.14	8.90	-4.482	0.001*
Lingual	34.00	8.77	53.43	7.68	-4.409	0.001*
Total	33.43	7.49	54.79	7.76	-5.238	<0.001*

Data expressed as mean ± SD
SD: standard deviation
*P: Probability   *: significance <0.05*

Test used: Student's t-test (Unpaired)

Table (2) Comparison of microleakage between S & C.

	S		C		t	P
	Mean	±SD	Mean	±SD		
Buccal	208.57	40.05	329.14	24.84	-6.769	<0.001*
Lingual	203.29	25.66	316.29	23.69	-8.561	<0.001*
Total	205.93	31.45	322.71	23.27	-7.898	<0.001*

Data expressed as mean ± SD
SD: standard deviation
*P: Probability   *: significance <0.0*
Test used: Student's t-test (Unpaired)

FIGURES:

Figure (1): Tooth fixed in epoxy resin blocks 2mm below the cement-enamel junction.

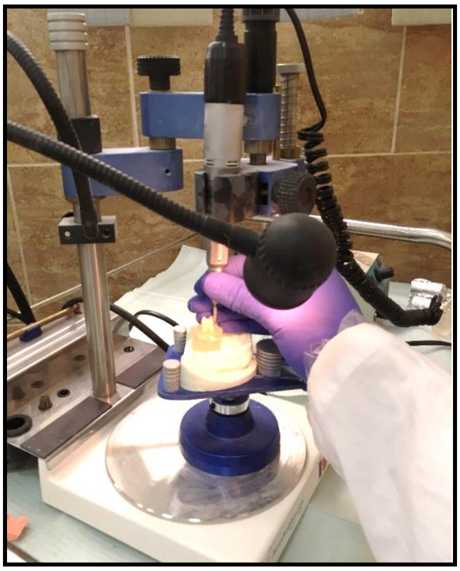

Figure (2): Teeth preparation using straight headpiece fixed to dental surveyor.

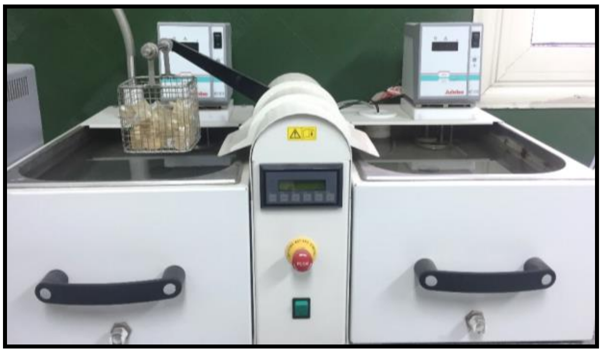

Figure (3): Accelerated artificial aging using thermal cycling device

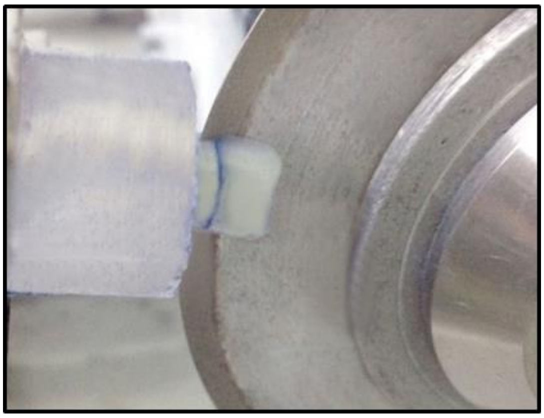

Figure (4): Teeth sectioning bucco-lingually using isomet cutting machine.

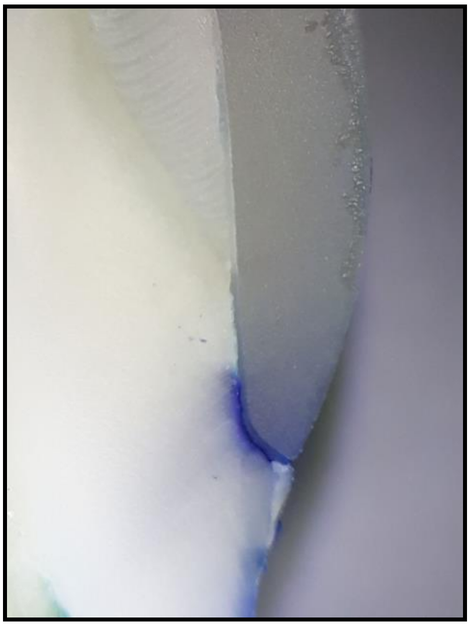

Figure (5): Methylene blue dye penetration.