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Marginal and Internal Accuracy of CAD/CAM all Ceramic Crowns Fabricated with two Types of Direct Digital Impression Systems (An *In Vitro* study)

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ABSTRACT

Direct optical impression system with or without powder opacification are commonly used in fixed prosthodontics, but little information is offered about the effect of the powder parameter on the accuracy of the intra-oral optical scanner. The objective of this present in vitro study was to evaluate the marginal and internal fitness of all ceramic crowns fabricated with direct powder and powder free system (Bluecam camera and Omnicam camera). Twenty four sound upper first premolar teeth of similar size were collected. Standardize preparation of all teeth samples were carried out to receive all ceramic crown restoration with deep chamfer finishing line (1mm), axial length (4mm) and axial convergence (6 degree). All specimens were then divided into two groups according to the type of intra-oral digital impression technique: Group A, Twelve prepared teeth were scanned directly using Omnicam camera; Group B, twelve prepared teeth were scanned directly using Bluecam camera. VITABLOCS MarkII for CEREC/ inlab was used to construct all ceramic crowns for each tooth sample using CEREC MCXL Milling machine. Marginal and internal discrepancy was measured at eight points per tooth using replica technique and stereo- microscope at (120X) magnification. ANOVA and T test post Hoc tests were used to identify and localize the source of difference between the two groups. It was found that there is non-significant difference in the marginal and internal gap mean values between (group A and group B). From the above result we can conclude that the two types of intra-oral camera (powder-free Omnicam and powder based Bluecam) have the same accuracy.

Key words: Internal Fitness, Replica Technique, Intra-oral Digital Impression

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INTRODUCTION

Using of the computer aided design/ computer aided manufacturing for the production of the dental restoration has been increase with the last decade. The accuracy of the digital impression is a major factor that might influence the accuracy of adaptation of the fixed dental restoration [1]. Presently; the data acquisition is either achieved directly in the patient mouth or indirectly after taking an impression and cast constructing. Regardless of the impression mode that used, clinical factors such as; blood, saliva and the movement during impression taking might affect the reproduction of teeth [2, 3]. Intraoral scanner allows the dentist to directly achieve the data from the prepared teeth and eliminating the impression and cast fabricating steps [4].

Two advantages of the direct optical impression are that they provide long term dimensional stability and that they are not subject to the contamination problem associated with the indirect impression materials [5]. Magnesium oxide or titanium dioxide powder has been applied to the tooth surface in order to escape reflections and to generate an optically measurable surface. In spite of powder-free system are available, but systems requiring powder persist in wide usage. Some powder

systems necessitate the prior application of an adhesive to hold the powder on the tooth surface, while other spray systems contain the adhesive [6]. The marginal and internal fitness is very critical issue in the success rate of the indirect restoration [7]. Crowns with inadequate fit are predisposed to failure due to the introduction of the luting material to the oral environment, thus leading to cement dissolution and micro-leakage licenses the maintenance of bacteria thus reduced periodontal standing and can cause inflammation of the vital pulp [8]. The marginal and internal adaptation depends on several factors but mainly it be influenced by the impression accuracy. The purpose of this study was to compare the accuracy of powder and powder-free direct introral scanner based on marginal and internal adaptation.

MATERIALS AND METHODS

Twenty four sound recently extracted maxillary 1st premolar were collected, the root of each tooth were fixed in an individual block of acrylic to about (3mm) by the aid of surveyor. Each specimen was prepared to receive all ceramic crowns with flat occlusal surface; (1mm) deep chamfer finishing line was measure with digital caliper, 6 degree axial tapering and (4mm) axial length (fig. 1)

Figure 1: The prepared tooth sample with final design.

Twenty four prepared teeth were divided into two groups (Twelve samples with each group) according to the type of the direct digital intra-oral scanner. The teeth samples in group A were scanned using intra-oral digital scanning by Omnicam camera, and group B were scanned using intra-oral digital scanning by Bluecam camera. Prior to scanning, The each specimen with its acrylic base was reseated in its matching place inside a modified custom made model to reproduce natural dental arch, so each tooth sample will have neighboring and opposing teeth which was necessary in the scanning procedure (Fig :2) , all the scanning

Figure 2: The modified custom made model

Procedure were done according to the manufacturer's instructions. The ceramic Vita Mark II CAD /CAM crowns were then fabricated for all teeth samples.

The crowns for all groups were designed using the biogeneric software according to the recommended parameters, all the information were then sent to the milling machine CEREC MC XL, a new set of milling burs were used for the milling of each group.

Measurement of the marginal and internal gap

The marginal and the internal discrepancy of the crown were calculated by the replica technique. Auto mix light consistency addition silicone material (Ivoclar vivadent AG, FL-9494 Schaan / Leichtenstein, Italy)) was mixed and poured inside the crowns, and the crown then was seated on the prepared abutment tooth for 2 min with finger pressure (Fig. 3). Five minutes after the light body material was mixed, the crown was detached from the abutment tooth carefully.

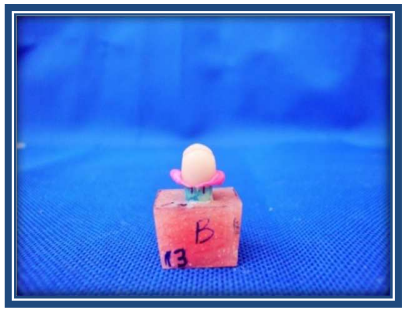

Figure 3: ceramic crown with light body seated on the abutment tooth

Auto mix heavy consistency addition silicone material (Ivoclar vivadent AG, FL-9494 Schaan / Leichtenstein, Italy) was mixed to seal the inside of the light body silicone of each crown. After setting, the crown and the two layers of silicone material were separated. No internal adjustment of the crowns was performed before obtaining the measurements [9]. The silicone materials replica achieved from each crown were sectioned into two pieces with a razor blade. They were cut bucco-lingually with a careful movement to obtain equal sections and to cut perpendicular to the surface (Fig. 4). The sections were placed under a measuring stereo-microscope (ST60 series, China), the digital images were captured and measured utilized IMAGE J software (Image J 1.32, U.S. National Institutes of Health, Bethesda, MA, USA) that estimate the value in pixel [10]. The sectional replica were observed and photographed at 120X magnification and calibrated using a photograph of a (1mm) increment take at the same focal Length and input

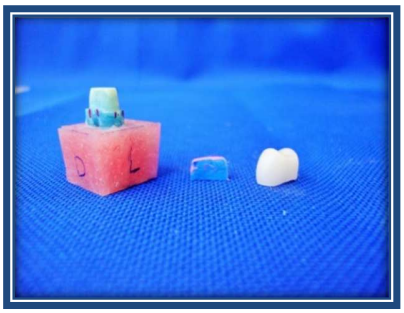

Figure 4: silicon replica with ceramic crown and abutment after separation and sectioning of the replica

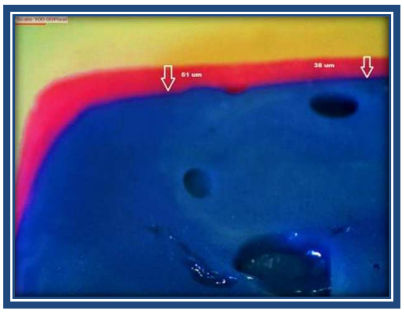

Figure 5: measurement of the internal gap in occlusal

Into (IMAGE J) by the option of set scale [11] that converted all calculated readings from pixel to (μm). Eight different points were evaluated on the bucco-lingual sections of each crown (Fig. 5). A total of 24 crowns were measured, and in an effort to escape mistakes when selecting starting and ending points of the discrepancies, all measurements were completed by one operator. The marginal gap was measured according to terminology reported by [12]. All measured data, which was obtained from the bucco-lingual sections, was averaged based on four locations: the margin, chamfer area, axial wall, and occlusal area.

Statistical analysis

Data were collected and analyzed using SPSS (statistical package of social science) software version 15 for windows XP Chicago, USA.
The following statistics were used:
A- Descriptive statistic: including mean, standard deviation, statistical tables and graphical presentation by bar charts.
B- Inferential statistics
1- One way analysis of variance test (ANOVA) was used to see if there were any significant differences among the means of groups.
2- T test was carried out to examine the source of differences among the four groups.

RESULTS

Total of (192) measurements of vertical marginal and internal gap from two groups were recorded, with 8 measurements for each crown. Table (1) and (2) showed the Descriptive statistics and side difference of marginal and internal fitness of the two groups. Table (3) showed that there is a statistically significant difference between the Bluecam group and Omnicam group only in the chamfer and occlusal area.

DISCUSSION

Many studies [13, 14] stated that marginal gap in the range of (100 µm) being clinically acceptable, additionally, a number of researchers found that crown restorations with marginal gap less than.

Table 1: Descriptive statistics and side difference of marginal and internal fitness of group A in various position

Positions	N	Mean	Std. Deviation	Std. Error of Mean
Marginal	12	25.8333	4.88194	1.40929
Chamfer	12	49.0833	4.79030	1.38284
Axial	12	40.5417	5.21562	1.50562
Occlusal	12	50.0833	6.17117	1.78146
Total	48	41.3854	11.07289	1.59823

Table 2: Descriptive statistics and side difference of marginal and internal fitness of group B in various positions

Positions	N	Mean	Std. Deviation	Std. Error of Mean
Marginal	12	26.0833	4.62618	1.33546
Chamfer	12	52.6667	2.33874	.67514
Axial	12	44.4583	4.02525	1.16199
Occlusal	12	55.2500	5.84847	1.68831
Total	48	44.6146	12.29653	1.77485

Table 3: Comparing the marginal and internal fitness between group A and group B

Position	Descriptive statistics				Comparison (d.f. = 22)	
	Group A		Group B			
	Mean	S.D.	Mean	S.D.	t-test	p-value
Marginal opening	25.833	4.881	26.083	4.626	-0.129	0.899 (NS)
Chamfer area	49.083	4.790	52.666	2.338	-2.329	0.029 (S)
Axial wall	40.541	5.215	44.458	4.025	-2.059	0.051 (NS)
Occlusal area	50.083	6.171	55.250	5.848	-2.105	0.047 (S)
Total	41.385	11.072	44.614	12.296	-.373	0.821 (NS)

120μm are more prospective to be successful [15]. Accordingly, all the values of marginal and internal fitness achieved, from this study, were within the clinical acceptable limit. The results of this study showed that the accuracy difference between the two types of intra-oral cameras (Omnicam camera video sampling technique and Bluecam camera continuous images techniques) was statistically non-significant, which is in agreement and parallel with the results of preceding studies that exhibited no statistically significant differences between the technique of video sampling and that of stripe- light projection [16-18]. On the other hand, small degree of difference between (Omnicam camera 41.3854) and (Bluecam camera 44.6146) which in total agreement with a recent laboratory research which concluded that powder-free and powder-based systems can achieve comparable results [17]. Although there was no statistically significant difference between both types of direct digital cameras (Omnicam and Bluecam), teeth scanned with the powder- based system (Bluecam) showed higher mean value of marginal and internal gap than those scanned with powder-free system (Omnicam) with significant difference in chamfer and occlusal area . The explanation of that difference might be due to the fact that the layer of powder used in scanning procedure of Bluecam camera, which is essential to applied to prevent reflections of glossy surfaces, could lead to inaccurate measurements. This comes in total agreement with [18- 20] who stated that powdering may adversely affect the marginal fitness instead of improving it even if the scanners' program capable of taking the powder layer into account in the algorithm. The powder layer smeared to the tooth surface might results in a further thickness of 13-85μm, but the scan sprays might offer more detailed reproduction and well data quality of tooth impression when the powder coating is thin and well distributed [6]. Furthermore, poor-quality coating have been associated with defective marginal adaptation of the all-ceramic restoration [21], also the powder thickness varied due to different dentists that results in decreasing scan accuracy [22, 23]. As a conclusion the two types of intra-oral camera (powder-free Omnicam and powder based Bluecam) have the same accuracy with little priority for the powder –free system.

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