ASSESSMENT OF MARGINAL ACCURACY OF CAD CAM INTERIM MATERIAL BY TWO DIFFERENT TYPES OF DENTAL SCANNERS

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ABSTRACT

Background: Computer aided design /Computer aided manufacture (CAD/CAM) system is gaining more importance in the fabrication of dental restoration and the minimization of crown and fixed partial denture marginal gaps is an important goal in prosthodontics. The purpose of this study was to Evaluation marginal accuracy of CAD CAM PMMA by used two types of dental scanner(Imes I core& DOF freedom dental scanner) on different type of die materials (peek and metal). **Objective:** Evaluation of marginal fit of CAD CAM PMMA material by two different types of dental scanners (Imes - Icore scanner & DOF scanner)**. Material and Method:** An ideal prepared plastic right maxillary first molar with deep chamfer finishing line design was used as a pattern for fabrication master dies. The model was scanned and the master (metal & PEEK) dies were milled by CAD/CAM system. sixty PMMA crowns were fabricated on a metal& PEEK die and were divided into two major groups(30 crowns for each group) according to the dental scanner being used: first group**:** fabricated with Imes -Icore scanner; second group: fabricated with DOF freedom scanner. Each group further subdivided into two subgroups; 15crowns were fabricated on metal die and 15 crowns were fabricated on PEEK die for two major grope. Marginal gaps were evaluated on the master die at four defined points on each aspect (Buccal, Mesial, Lingual and Distal). Direct view technique was used with the aid of a digital microscope at a magnification of (110X) and (image J) program. **Results:** of this study showed that the lowest mean of marginal gap with crowns fabricated by DOF Freedom scanner on PEEK die (29.221±0.801μm); and highest mean of marginal gap with crowns

fabricated on Metal die by Imes - Icore showed a mean marginal gaps (54.448 ± 1.687μm). The data were statistically analyzed, using T tests which revealed highly significant differences (p<0.001) among groups. **Conclusion:** Imes -Icore scanner showed the higher marginal gap than the DOF freedom scanner, PEEK die material show lower marginal gap compared with metal die material. All measurement within acceptable marginal gap clinically.

KEYWORDS: CAD CAM Interim Material, Dental Scanners, Marginal Accuracy.

INTRODUCTION

Provisional restorations are an important part of prosthetic therapy procedures with fixed prostheses (i.e., crowns and bridges). Provisional restorations serve important roles during tooth preparation and until fitting, luting the final fixed restoration. These include pulpal tissue protection against physical, chemical, and thermal injuries; maintenance of positional stability and occlusal function; and provision of the prepared teeth with strength, retention, and aesthetics, which are essential to clinical success.[1-3]

Marginal accuracy of fit has been considered essential in assuring clinical success of fixed restorations.[4]"Kukubo reported that poor marginal fit causes complications such as luting agent dissolution, micro leakage, recurrent caries, hypersensitivity and periodontal inflammation.[5]

Most researchers agree that the clinically acceptable range of marginal discrepancy is from 50 μm to 120 μm".[6, 7]

The CAD/CAM systems have developed considerably, offering accuracy and more options. It can be envisioned that CAD/CAM technology developments will continue to offer dentistry more options for its use, including further CAD/CAM integration of procedures and imaging enhancements. With the advent of new interim crown materials, it has become imperative to evaluate its strength in order to select the appropriate interim crown and partial fixed dental prosthesis material. However, there is lack of information on marginal gap of interim materials using CAD/CAM systems.[8]

In dentistry, a highly updating in knowledge in both techniques and technology occurred throughout the last years. Achieving high quality restorations in a short period was the major challenges. The present technologically inclined approach to treatment; has led to the

development of the (Computer Aided Design/Computer Aided Manufacture) (CAD/CAM) system. CAD/CAM in dentistry can be defined as a procedure by which a prepared tooth or model of it is scanned by a digital scanner, to produce a data that are used to design either coping or restoration, which in turn; is used to generate a cutting program for manufacturing the coping/restoration with computerized milling machine".[9]

The scanner device is a tool by which the tooth structures can be measured, and transformed into digital data. The accuracy of scanning is a major factor that can affect the fit of restorations. Currently, either the data records directly in the patient's mouth or indirectly by scanning a master cast after taking an impression. The Intraoral scanning allows the dentist to obtain the data from the prepared teeth directly. Thus, it has an advantage that no impression and cast model are needed".[10]

Special software is provided by manufacture for the design of the various kinds of dental restorations such as crown and fixed partial denture framework or the fully anatomical restorations. A (3D) image of the die is appeared on screen and can be rotated for observation from any angle. Currently, some of CAD/CAM systems utilize software modifier that allows the designing of crown shape by selecting the proper tooth element from the library and then modeling the crown to fit in with the remaining dentition".[11]

MATERIALS AND METHODS
An ideal prepared plastic right maxillary first molar deep chamfer finishing line (0.8) , 2mm reduction occlusally[12] (As in figure 1)was used for the construction of a master metal die and master PEEK die.

Figure (1): An ideal prepared plastic right maxillary first molar.

A base of the plastic die was made by placing the it in the plastic ring and pouring the die stone to 2mm below cement enamel junction.

Dental surveyor was used to make the long axis of the die lied perpendicular to the horizontal plane of the stone base.

The plastic die with stone base was scanned with light dental scanner (DOF,full HD, 5 M pixel /,Korea) then digital model of die transferred to the CAM software to start the milling process of the metal die &PEEK die by using the milling unit(VHF S1,K5 impression machine (Germany) which was loaded with cobalt chromium disc (10mm) (Interdent, Travagliato (BS) Italy) for metal die and was loaded with (polyether ether ketone (PEEK) disc, 14mm, Germany) for PEEK die.

Scanning the metal die and PEEK die with Imes – Icore scanner & scanning the metal die & PEEK die with DOF Scanner

All crowns were designed with the exocad software, Select Crown, Material "PMMA block CAD" and Shade A2,. The same design is programmed for both type of dental scanner system.

To standardize the dimension and shape of all test crowns, the crowns parameters were cement thickness was (80μm) Minimum circular thickness : 1500um and adhesive space of 1000um from the finish line, the designed form were sent to milling machine CORITEC 250i for milling.

All tested crowns were individually seated on the master dies for examined the vertical marginal gap by the researcher,30 crowns on PEEK die &30 crowns on metal die using digital microscope at magnification of X110.

Four line angle were drawn (mid – buccal, mid – lingual, mid –mesial, and mid – distal) and four point determined on each surface of the metal die and crown (two points at the edge of the midline while the other points were at distance (1mm) from the previous one on both left and right side.[13]

To ensure accurate seating of the crowns on the master dies and hold them in place during measurement, custom designed specimen holding device, composed of screw holding part

with a load sensor was used in order to applied pressure (5 kg)[14], the digital image of the margins were then captured and analyzed using image processing program (Image J).

RESULT

(Table 1): The marginal accuracy of I MES ICORE and DOF Freedom scanner on metal die.

Metal	N	Mean	SD	Std. Error	Range Mini.	Maxi.	t- test (P-value)
I MES ICORE	15	54.448	13.068	1.687	28.493	79.963	P=0.00
DOF Freedom	15	37.069	6.436	0.831	24.725	51.282	Highly sign.
Total	30						(P<0.01)

(Table 2): The marginal accuracy of I MES ICORE and DOF Freedom scanner on PEEK die.

PEEK	N	Mean	SD	Std. Error	Range Mini.	Maxi.	t- test (P-value)
I MES ICORE	15	39.475	9.465	1.222	25.735	64.338	P=0.00
DOF Freedom	15	29.221	6.202	0.801	20.147	41.209	Highly sign.
Total	30						(P<0.01)

(Table 3): The marginal accuracy by using of I MES ICORE scanner on metal die and PEEK die.

I MES ICORE	N	Mean	SD	Std. Error	Range Mini.	Maxi.	t- test (P-value)
Metal	15	54.448	13.068	1.687	28.493	79.963	P=0.00
PEEK	15	39.475	9.465	1.222	25.735	64.338	Highly sign.
Total	30						(P<0.01)

(Table 4): The marginal accuracy by using of DOF Freedom scanner on metal die and PEEK die.

DOF Freedom	N	Mean	SD	Std. Error	Range Mini.	Maxi.	t- test (P-value)
Metal	15	37.069	6.436	0.831	24.725	51.282	P=0.00
PEEK	15	29.221	6.202	0.801	20.147	41.209	Highly sign.
Total	30						(P<0.01)

DISCUSSION

Nowadays, the attention in CAD/ CAM systems in dentistry is increasing because these systems can decrease the costs related to the traditional procedures of producing dental restorations associated with manpower and labor-intensive laboratory processes. Also, these systems are currently used in the manipulation of high-strength ceramics, such as zirconia or

alumina, as well as, this technology have the ability to produce an accurate fit and individual design, simple handling characteristics, and time consuming production processes; in addition to that, the components of CAD/CAM system are extremely homogenous and biocompatible.[15]

The vertical marginal gap measurement is the most frequently used method to quantify the accuracy of fit of the crown restorations.[16]

The "perfect margin" is defined as two adjoining surfaces which have no interruption of the continuous margin and merge into each other without any difference in level.[17]

METHODOLOGY

Master die

In this study, an ideal prepared plastic tooth#16 with deep chamfer finishing line (0.8) all around was selected which enable more accurate seating of the crown.

Many studies show that either a chamfer or a shoulder finish line can accomplish clinically acceptable margins.[18]

i.   The metal die was fabricated by using CAD/CAM to simulate the shape of an ideal prepared plastic tooth to receive the restoration.[19, 20]

ii. The PEEK die was fabricated by using CAD/CAM to simulate the shape of an ideal prepared plastic tooth to receive the restoration.[21]

Specimen holding device

In this study, a specimen holding device was specially designed with screw that secured the PMMA crowns on the master models, while holding the specimens on the stage of the microscope during measurement. Furthermore, the device designed to have a load sensor attached to a digital scalar, in order to ensure the application of a uniform standard load of (5 kg) over each crown during measurement.[12, 22, 23]

Points of measurement

The number of measurement points per each crown used in previous studies has varied greatly where it ranged from 4 points to more than 30. In this study The measurement of vertical marginal are made   at four points on each axial walls so total was sixteen point for each crown. The same measurement points were used in other studies done by.[22, 24]

Microscopical examination

A variety of methods has been used to evaluate the marginal adaptation of dental restorations such as direct viewing, cross section view, impression replica technique, SEM and clinical examination.[25, 26] In the current study, direct viewing method by a digital microscope and image analysis measurement (image J) was selected because it is a non-destructive, rapid, easy, simple method and reduced the chance of errors that may be accumulate from multiple process, which may affect the accuracy of results.[12, 27, 28]

RESULTS

Several authors have been estimated maximal marginal gap values after a clinical examination of more than 1000 crowns at 5 years,[29] concluded that a marginal opening of no more than 120 μm is clinically acceptable.

For CAD/CAM restorations, the generally acceptable marginal gap discrepancies are reported between 50 and 100 μm.[18, 30-32]

Due to the continued growth of the CAD CAM market, the demand for interim crown and FDP materials for CAD CAM cases has been constantly rising. This applies mainly to materials suitable for the fabrication of long-term temporaries. Evaluation of the mechanical properties of interim fixed dental prosthesis materials is important to prevent failure of a temporary restoration from the beginning, after fabrication and insertion.[33]

In this study, PMMA crowns scanned by Imes - Icore scanner on PEEK die showed a mean marginal gap of (39.475 ±1.222 μm), While all crowns fabricated on Metal die showed a mean marginal gaps (54.448 ± 1.687μm) while PMMA crowns scanned by DOF Freedom scanner on PEEK die showed a mean marginal gap of (29.221±0.801μm). And on metal die the mean marginal gap(37.069 ± 0.831 μm) All values were within the clinical acceptable value.

Effect of scanner on the vertical marginal gap.

The precision of dental scanners depended on two different parameters, the first parameter is the resolution of the receptor sensor (camera or receptor matrix) of the optical scanning system, and second parameter is the precision of collected data (dental scanner should be acquired enough points cloud from the object's surface with a certain accuracy and density that mean that points cloud should be sufficiently spread across the surface have to be

determined), and then the software of the next step can be created a complete and accurate surface with enough reproduction of detail.[34]

The effect of camera resolution in addition to the projector is a key factor in the accuracy and clarity of the image of the scanner.[35]

Up to our knowledge ;there is no previous studies was done to compare the marginal quality of the restoration produced by two types of light dental scanners (imes icore and DOF freedom).

In this study the marginal accuracy of DOF freedom scanner was more than IMES ICORE According to the data collected , the reason may be due to the accuracy of the camera, when increase the resolution of camera lead to increase the accuracy of image[36] since the camera's accuracy of DOF scanner is about 5 megapixels while camera's accuracy for IME ICORE is about 2 megapixels.

The other cause may be due to the difference in the scanner design in the DOF freedom scanner the scan stage is fixed while the camera is movable, while in the IMES ICORE scanner the camera is movable and the scan stage is fixed.

This movable of the object during scanning may attribute in decrease the accuracy of the visual image(which mean reducing the number of scan position per object lead to increase accuracy of image)(www.cmosis.com; www.Onsemi.com).

Effect of die materials on the vertical marginal gap.
The purpose of the use of scan spry is to increase the resolution of visual image by preventing the reflected light from the scanned materials, This spray is used prior to scanning, and should only be used for non-intraoral scanning, such as on crowns, models, and impressions.(dental.keystoneindustries.com).

In this study, the marginal accuracy of PEEK die with DOF freedom scanner which done without scan spray was more than PEEK die with Imes - Icore scanner which done with scan spray. According to the data collected, the reason may be due to the scan spray which applied on the die before scanning ; The results of this study disagree with[37] who founded that A powder application before scanning improved the vertical fit of crowns; The present study is

also not compatible with[38, 39] who found that The matte finish could improve the marginal fit of the crowns by improving detection of the finish line of the preparation.

CONCLUSIONS

Within the limitations of this study, the following conclusions can be derived:

1. The mean vertical marginal gaps of PMMA that fabricated according to the two types of dental scanner were within the clinically acceptable marginal gap for two types of die.

2. Marginal accuracy values of restoration produced by DOF freedom scanner is more precise than marginal accuracy value of restoration produced by Imes - Icore scanner with a highly significant differences.

3. Differences were present in the vertical marginal between two types of die; that show PEEK die is more accurate than metal die that scanned by two different dental scanner.

These results indicated that scanning type &die material will affect the marginal accuracy of CAD/CAM restorations.

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