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## Clinical Study Comparing The Internal Adaptation And Marginal Fit Of All-Ceramic Zirconia Fixed Restorations Obtained From Conventional And Digital Intra oral Impression Techniques.

(Randomized Controlled Clinical Trial)

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### Abstract

**Statement of problem:** Zirconia crown restoration may be affected by the impression technique used for its construction which may affect the longevity and success of the restoration through affecting marginal fit and internal adaptation. Purpose: The aim of this study was to compare the marginal fit and internal adaptation of the zirconia restorations obtained from two impression techniques: 1- Indirect digitalization using conventional impression technique (dual mix two step technique) 2-Direct intraoral digitalization technique using intra-oral scanner.

**Materials and methods:** Twelve patients were provided with sixteen ceramic zirconia-single crowns. For each tooth used in this study, two crowns were made, one made by direct intraoral digital impression technique (CEREC Omnicam, Sirona) (Intra-oral digital impression technique group, IDI) and the other one made by indirect digitalization of the cast which constructed from the conventional two-step addition silicone impression technique (Conventional impression technique with indirect scanning group, CIS) To register the space between the inner surface of the restoration and the abutment tooth surface, an in vivo impression replica technique was used. The crowns were first filled with a light-body silicone material on the abutment teeth with finger pressure for 10 seconds and then fixed with a cotton roll while the patient closed his mouth. After two and a half minutes the crowns were dragged off the preparation with the light-body material adhering to the inner surface of the crowns were stabilized using another more viscous polyvinylsiloxane material. After setting the replica material consists of both silicone materials were simultaneously removed from each crown and were cut with a sharp scalpel blade in both mesio-distal and bucco-lingual directions, resulting in four sections to be measured per abutment. Internal Adaptation and marginal fit were measured in microns using stereomicroscopy with a magnification of  $\times 16$ . Measurements were taken at different landmarks: margin, chamfer angle, axial, crest, and occlusal fosse. Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Data were presented as mean, median, standard deviation (SD), minimum, maximum and 95% confidence interval (95% CI) for the mean values. Mann-Whitney U test was used to compare between the two groups. Friedman's test was used to compare between different sites within each group. The significance level was set at  $P \leq 0.05$ .

**Results:** No statistically significant differences were found ( $P > 0.05$ ) between the two groups. The mean of overall internal misfit were  $244.2 \mu\text{m}$  ( $SD = 62.2$ ) for group IDI and  $269.7 \mu\text{m}$  ( $SD = 76.1$ ) for group CIS.

**Conclusion:** Monolithic zirconia-based ceramic crowns fabricated using intraoral scanners are comparable to elastomer conventional impressions in terms of their marginal and internal fits. The mean marginal fit in both groups was within the limits of clinical acceptability.

**Keywords:** Digital impression/CEREC Omnicam scanner/ Monolithic zirconia ceramic crowns/ CAD/CAM/ Intraoral scanner/ Marginal fit/ internal adaptation/ Replica technique.

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## Introduction

### Introduction

Impressions are a critical component in the construction of fixed dental prostheses. Dental impressions can be taken by different techniques one of them is the conventional impression technique into which a cast is produced after an impression has been made with a tray filled with an elastomeric impression materials available for final impressions as vinylpolysiloxane, and polyether materials. Although the conventional technique is still the most common method for transferring information from the patient mouth to the dental laboratory when making indirect restorations and a high quality impressions are achievable by these impression techniques. It remains a cumbersome procedure for both dentist and patient and during the Impression-making procedure, many errors can occur that lead to a less than ideal prosthesis as a lot of factors can limit the accuracy of conventional impression-making include errors associated with the intraoral phase like tray selection, inadequate adhesive application, poor salivary and hemorrhage control, inadequate soft tissue retraction in addition to that limitations related to the impression material properties like flow and hydrophilicity, short working time, tearing and deformation of the impression during removal, dimensional instability of the set impression, required disinfection, and errors associated to the laboratory procedures during pouring the impression including the water/ Powder ratio, vacuum versus hand mixing, and the type of dental stone and its compatibility with impression materials. In addition, conventional impression-taking may cause patients' discomfort like gagging sensation, unpleasant taste, breathing difficulty and teeth sensitivity.<sup>(4)</sup> In order to minimize process errors result from conventional impression taking and model the number of steps involved should be minimized so it is only logical to directly scan the preparations in the patient's mouth and then the information gathered by intra-oral digital scanners can be entered directly into the digital CAD/CAM production chain The CEREC system (Sirona, Bensheim, Germany) was the first digital impression and CAD-CAM device to come on market in 1987, the

device was able to produce single crowns that expressed acceptable survival rates of 94.7 and 85.7% after five and ten years, respectively.<sup>(1)</sup> Intraoral scanners play an important role in the development of digital dental technology because they are the first step towards a full digital workflow of prosthetic fabrication. Intraoral scanning has been reported to give higher efficiency, decrease patient discomfort, reduce possible distortion of impression materials, and allow for three-dimensionally previsualisation of the preparation, decrease potential cost. Communications between professionals as well as between dentists and patients are becoming more convenient. So the digital impression technique is winning patients' and doctors' preference. One of the most significant advances in this field has been the production of high resistance all-ceramic restorations that till now can only be produced with CAD/CAM Systems. The popularity of these materials, such as zirconia, has increased in the last decade due to their mechanical Esthetic, and biocompatibility properties. In addition to the physical properties and biocompatibility, the predictable production of suitable marginal adaptation which is one of the most important factors for long-term success of fixed restorations. Digital impression is proposed to be an alternative to conventional impression technique However, the scanning quality of digital impression was greatly affected by patient-related factors, such as patient movement, limited intraoral space, intraoral humidity and saliva flow, tooth shape was also an important factor related to precision. Therefore, the accuracy of a digital intraoral impression compared with a conventional silicone impressions technique is an important issue that needs to be compared. The aim of this study was to compare the marginal fit and internal adaptation of the ceramic zirconia fixed restorations obtained from two impression techniques Indirect digitalization using conventional dual mix two step technique and Direct intraoral digitalization technique using CEREC Omnicam, Sirona intra-oral scanner. The tested null hypothesis was that there is no significant difference in marginal and internal misfits between crowns fabricated from both impression techniques.

## Materials and methods

### Study design:

This randomized clinical trial and its study protocol were approved by the ethics committee of the Faculty of Dentistry, Cairo University. All patients enrolled gave consent after being informed about the aims and study protocol. The inclusion criteria were patients in need of one or more than one single crown, be physically and psychologically able to tolerate conventional restorative procedures, subjected teeth should be free from any clinical signs or periodontal symptoms, normal physiological occlusion with bilateral posterior occlusion, capable of read and write in order to sign an informed consent. The exclusion criteria were as follows: advanced periodontitis affecting the mobility of the teeth (mobility grade 2 or more), pregnant or lactating females, marginal preparation situated deeper than 1 mm Sub gingival, patients with psychiatric problems or unrealistic expectation, patients with endodontically treated teeth which is not functioning or showing any signs or symptoms that need endodontic retreatment, occlusion problems, absence of posterior stopper and poor oral hygiene. From the initial 20 candidates, 12 patients (7 females and 5 males) satisfied the inclusion/exclusion criteria and were enrolled in the study. The 12 patients were provided with sixteen ceramic zirconia-single crowns. For each tooth used in this study, two crowns were made, one made by direct digital impression technique and the other one made by indirect digitalization of the cast. A total of 32 zirconia ceramic single crowns were made for the study.

### Teeth preparation:

All teeth preparations were performed by one single operator (researcher) for standardization. There were in total 4 molars, 6 premolars, 2 canines, 2 lateral incisors and 2 central incisors in this study with 8 in the upper jaw and 8 in the Lower jaw. Prior to preparation, all patients received local anesthesia. Preparation of the abutment teeth was performed with distinct chamfer finish lines, where the location of the finish lines was Supra gingival. Guidelines for abutment tooth preparation for all ceramic reconstructions

comprised a tapering of the axial walls by 8–10°, a circumferential axial reduction of the tooth between 1.2–1.5 mm, and an occlusal or incisal reduction of approximately 2 mm. All sharp line angles that might serve as a point for stress concentration were rounded using finishing tapered rounded end diamond stone. After tooth preparation, a provisional restoration was placed using a temporary resin-based material (PERFRCTEMPII, DENTMAT) and bonded with non-eugenol temporary cement (Cavex eugenol free Temporary Cement, Cavex Holland B.V.).

### The impression making phase:

#### Indirect digitalization using conventional impression technique (CIS)

Approximately 1 week after preparation, the patients returned for a second appointment. The teeth were prepared for impression with two retraction cords, sizes #0 and #1 (Ultrapak, Ultradent Products, South Jordan, UT, USA), The retraction cords were placed in the sulcus; the size #0 cord remained in the sulcus during the entire impression-taking procedure, and the size #1 cord was removed prior to impression-taking to allow an accurate display of the preparation and surrounding soft tissues. The same retraction cord technique was used for both the IDI and CIS groups. A polyvinyl siloxane (PVS) material (Betasil impression material, Mullar omicron) was used with two-step impression technique (putty/wash). The light viscosity was applied on the full arch putty impression that was taken before teeth preparation by using automatic mixing tips and dispensing with impression gun which produced complete homogenous mix after the setting time of the impression (2 min.) the impression was snap removed from the patient mouth. The opposing dental arch impression was made with irreversible hydrocolloid impression material in a stock metal tray and the bite registration was made using injectable elastomeric bite registration material (Imprint 4 Bite Vinylpolysiloxane bite registration material). The impressions were disinfected using impression disinfectant spray (Bossklein Ethanol, Didecyldimethylammonium chloride impression disinfectant spray Topdental Ltd., England, UK) then inspected by using 3× magnification lobes (ERC0 Vision HD, Akura

Medical, china) verifying that all impression surfaces of the abutments were free from voids or air bubbles and then poured with type IV dental stone one hour after removal from the patient mouth. After hardening of the stone cast it was separated from the impression and scanned by means of the extraoral scanner using blue led light (inEos X5 extraoral scanner,cerec, Sirona)

### **Intraoral digital impression: (IDI)**

A digital optical impression was taken using a 3D powder-free intraoral scanner (CEREC Omnicam, Sirona) CEREC Omnicam scanner is a light scanner that uses a white LED and it works under the principle of optical triangulation. The scanning procedure (data acquisition) was done following the manufacturer's instructions. The acquisition was divided into four consecutive sequences: Occlusal, Buccal, Lingual and Proximal. In occlusal scan the CEREC Omnicam was moved slowly in the occlusal direction from the distal positioned tooth over the prepared tooth to the mesial-positioned tooth. In buccal scan The CEREC Omnicam is on the adjacent tooth, in the mesial direction to the preparation then rotated approximately 90° toward the buccal surface then guided over the entire buccal distance in the distal direction over the prepared tooth. In lingual scan the CEREC Omnicam is on the tooth that is positioned next to the preparation in the distal direction then rotated by 90° in the buccal direction to the other side, to around 90° in the lingual direction. Then guided over the entire lingual distance in the mesial direction over the prepared tooth. In proximal surface scan the scanner was moved in the distal and mesial direction by using a wave motion in the occlusal direction over the prepared tooth.

### **Construction phase:**

After approving the preparation on the screen of CAD/CAM machine the laboratory procedure for crown fabrication for the indirect digitalization using conventional impression group (CIS) was done using Sirona in Lab CAD SW version 4.2.5. Crown fabrication was done following the standard protocol of CAD/CAM crown fabrication by Sirona starting with the "SCAN PHASE" using inEos X5 extra-oral scanner. The

resulting digital 3-D virtual models obtained from intra-oral and extra-oral digital scanning were then subjected to the same steps of digital workflow for crown fabrication. for standardization purposes, the monolithic zirconia crowns of all groups were milled by the same milling device (CEREC MC XL X5, Sirona, Germany)under proper water cooling after completion of the milling process, all crowns were placed inside the ultrasonic cleaner(ICS Plastic Ultrasonic Cleaner, India) and then dried 10 minutes at 150°C (302°F) in the drying cabinet and then densely sintered using in Fire HTC speed furnace with pre-programmed settings according to the manufacturer's instructions.

### **Try-in phase:**

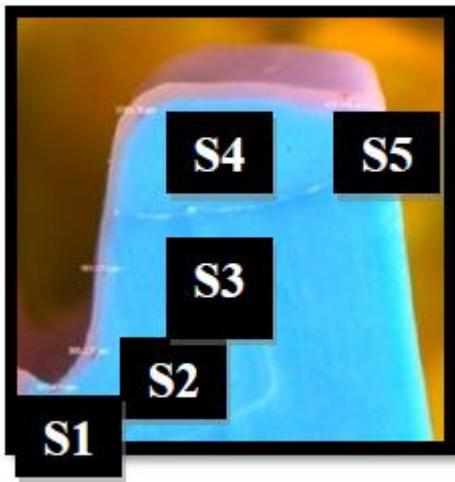
After milling and sintering the zirconia crowns were placed on the master cast for try-in the proper seating and margin placement. At the patient try-in appointment, the provisional crown was removed and the preparation thoroughly cleaned with water and polishing brush. Crowns were checked intra-orally for any needed adjustment in seating, interproximal contacts, margin location, occlusion and contour which was done under constant water cooling. Crowns were then polished by using soft, diamond rubber polishers (DC9519F.RA.055, komet, Germany)

### **Measurement of the marginal and internal fit using replica technique:**

To register the space between the inner surface of the restoration and the abutment tooth surface, an in vivo impression replica technique was used. The crowns were first filled with a light-body silicone material seated on the abutment teeth with finger pressure for 10 seconds and then fixed with a cotton roll while the patient closed his mouth to simulate clinical cementation of the restoration after two and a half minutes (intraoral setting time of the impression material); the crowns were dragged off the preparation with the light-body material adhering to the inner surface of the crowns were stabilized using another more viscous polyvinylsiloxane material. After setting the replica material consists of both silicone materials were simultaneously removed from

each crown the silicone replicas were cut with a sharp scalpel blade in both mesio-distal and bucco-lingual directions, resulting in four sections to be measured per abutment. For each tooth two replica were made and they were randomly allocated in closed envelope coded with digit for blind examination during measurement. All sample measurements were carried out by one examiner who was blinded. Cross-sections were adjusted horizontally on modeling clay to obtain a parallel orientation to the microscope's plate. Replica film thickness was measured at mesial, distal, buccal, and lingual locations using a stereomicroscope M-80 at magnification  $\times 16$ , with a built-in charge-coupled device camera that captured the zone to be analyzed.

For each cross-section, the following five marks were assessed (Fig. 1).



**Figure (1) Posterior replica with locations of the measurement points. (S1) Marginal gap. (S2) Chamfer discrepancy. (S3) Axial adaptation. (S4) Crest discrepancy. (S5) Fosse discrepancy.**

**Marginal gap (S1):** the vertical distance from the restoration to the abutment surface close to the preparation finish line. **Chamfer discrepancy (S2):** the distance from the restoration margin to the abutment surface at the right angle of the preparation finish line. **Axial adaptation (S3):** the horizontal measurement from the internal surface of the restoration to the axial wall of the preparation, 2 mm coronal to the cavosurface line angle. **Crest discrepancy (S4):** measured from the restoration to the abutment at the highest point

of the crest or described as the bisector of the angle between the straight line attached to the incisal or occlusal plateau and the straight line applied to the axial wall. **Fosse discrepancy (S5):** measured from the restoration to the abutment at the lowest point of the fosse of the preparation or middle of prepared incisal edge. All measurements were recorded in microns and exported to a spreadsheet (Microsoft Excel 2007, Microsoft Corp, USA). The overall misfit discrepancy was also calculated using all measures from each group (20 measures  $\times$  32 crowns), so as to obtain an overall misfit comparison between both impression techniques. Results were collected and statistically analyzed.

### Statistical analysis:

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Data showed non-normal (non-parametric) distribution. Data were presented as mean, median, standard deviation (SD), minimum, maximum and 95% confidence interval (95% CI) for the mean values. Mann-Whitney U test was used to compare between the two groups. Friedman's test was used to compare between different sites within each group. Dunn's test was used for pair-wise comparisons when Friedman's test is significant. The significance level was set at  $P \leq 0.05$ . Statistical analysis was performed with IBM®SPSS®Statistics Version 20 for Windows.

### Results:

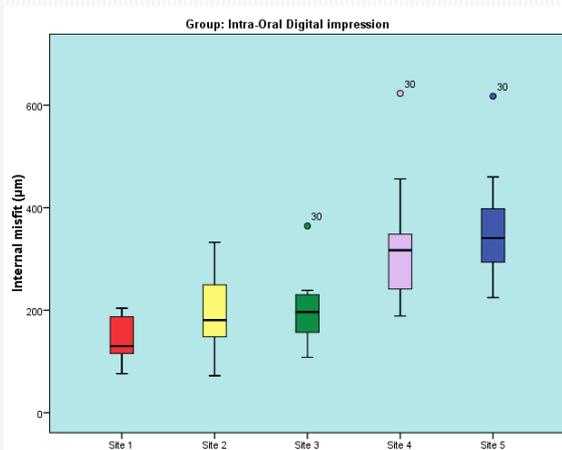
The means, standard deviations, median and lower/ upper confidence intervals for the internal misfit values (in microns) are shown in Table 1. The distribution of the results for both groups can be seen in the boxplot graphs shown in Figs. 2, 3 and 4. By comparing sites of measurements within each group it was found that in both groups there was a statistically significant difference between the sites 1, 2 and 3 and that for site 4 and 5 ( $P$ -value  $< 0.001$ ). Pair-wise comparisons between the sites revealed that there was no statistically significant difference between Sites 1, 2 and 3; all showed the statistically significantly lowest internal misfit values. There was no statistically significant difference between

sites 4 and 5; both showed the statistically significantly highest internal misfit values compared to other sites. For the areas studied, Student's t test was applied, and no significant differences were found for any area between two study groups ( $P > 0.05$ ), although digital crowns (group IDI) showed a tendency towards a better fit than conventional (group CIS). Mann-Whitney test showed no significant differences between the two study groups for the overall misfit ( $P = 0.468$ ). Thus, the null hypothesis was admitted.

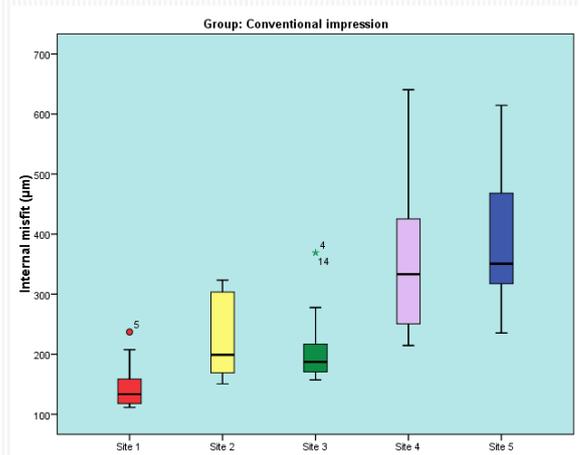
**Table (1):** Descriptive statistics and results of Mann-Whitney U test for comparison between overall internal misfit of the two groups

	Mean	SD	Median	Minimum	Maximum
Group I	269.7	76.1	273.8	182.8	423
Group II	244.2	62.2	230	172.7	410.5

\*: Significant at  $P \leq 0.05$

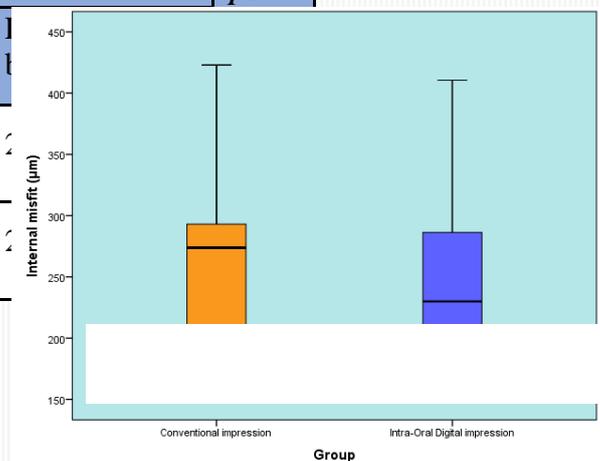


**Figure (2):** Box plot representing median and range values for internal misfit at different sites within conventional impression group



**Figure (3):** For internal misfit at different sites within intra-oral digital Impression group

**Figure (4):** Box plot representing median and range values for overall internal misfit



## Discussion:

Crown marginal adaptation along with high esthetic demand and high fracture resistance are important for the clinical success and longevity of the restoration. An increase in the marginal gap could increase cement dissolution, thereby increasing the potential for microleakage, plaque accumulation, recurrent caries and periodontal disease. On the other hand, an increase in the internal gap could decrease the fracture strength of ceramic restorations.<sup>(2)</sup> One of the important factors for production of restorations with accurate internal adaptation and marginal fit is the impression step. In (CAD/CAM), the transformation of the clinical situation into a three-dimensional data set can be achieved by direct or indirect digitalization. Indirect, extraoral digitalization starts with a conventional impression that is poured into a gypsum cast and then digitalized in the dental

laboratory<sup>(3)</sup> Although there have been advances in impression material technology, and such materials exhibit adequate stability and precision, factors such as impression technique, impression material, impression trays, and mixing techniques significantly influence the accuracy of the impression. Moreover, discomfort of the patient caused by gagging or an unpleasant taste remains associated with conventional impression techniques. Imprecision during impression taking is difficult to correct in subsequent laboratory procedures, and this influences the internal and marginal fit of the prostheses.<sup>(4)</sup> On the other hand, the development of chair-side digital impression technique using digital intra-oral scanner offers the advantage of simplifying the workflow. Moreover, intra-oral digital scanners have limitations in some clinical situations such as subgingivally located finish line and this is worsened by the presence of blood or saliva and limited accessibility in patients with limited mouth opening.<sup>(5)</sup> So for that purpose this in vivo study was designed to compare the marginal fit and internal adaptation of the ceramic monolithic zirconia crowns obtained from indirect extra-oral digitalization using conventional impression and digital impression technique using intra-oral chair side scanner. According to (Pekka Ahlholm et al., 2016)<sup>(6)</sup> who conducted a systematic review to evaluate the evidence of possible benefits and accuracy of digital impression techniques vs. conventional impression techniques. It seems that the accuracy of digital impression is at the same levels as conventional impression methods in fabrication of crowns and short FPDs, and thus both of these techniques can be used. For fabrication of implant-supported crowns and FDPs the digital impression systems also result in a clinically acceptable fit; however, for large, full-arch FPDs, the conventional impression technique results in better accuracy as compared to the digital method, that is why the conventional methods may be preferred. Digital impression making seems to be the preferred method over conventional impressions, with regard to time efficiency and patient preference but due to the controversy and relatively low number of studies additional investigations are needed to

confirm these findings. In the present study, the assessment was adopted to investigate the vertical marginal fit and internal adaptation of in coris tzi c zirconia single crowns clinically. Impression material used was additional silicone as it has high dimensional stability and accurate imprint recording. Two-step putty/wash impression technique was used as it is more accurate than one-step impression technique because in the two step technique, the fine details are registered by the light body material at the second step of the technique, which has better flow characteristics owing to its lower viscosity and decreased filler content,<sup>(7)</sup> while in the one-step impression technique, the tray material tends to push the syringe material off the prepared tooth, so it is impossible to control which material records the details of the margin of the preparation. Thus, critical areas such as the finish line might be captured by the tray material rather than the syringe material,<sup>(8)</sup> Y-TZP restorations are gaining popularity due to their good mechanical properties, esthetics, and biocompatibility. Nowadays, Y-TZP is used as a framework material for crowns and FPDs, both in the anterior and posterior region. However, the clinical success of the zirconia-based restorations has been questioned with the reports of veneering porcelain chipping. Therefore, monolithic or full anatomic zirconia crowns were developed to reduce these failures by eliminating the veneering porcelain layer and improving their clinical success and reliability. The continuous enhancements in its color and translucency gave a rising hope to full contour zirconia to become acceptable anterior restorations.<sup>(9)</sup> Assessment of the vertical marginal fit and internal adaptation of single crowns was done by using the in-vivo silicone replica technique and stereomicroscope with fixed  $\times 16$  magnification. The replica technique is accepted as a reliable and non-invasive means to determine the in vivo adaptation of crown-to-tooth surfaces.<sup>(10,11)</sup> The measurements were made at five points for each of four sections of the replica and with two replicas for each restoration (40 measures  $\times$  16 crowns) which may help in getting more accurate measurements. Besides its reliability, the replica technique has several other advantages that make it a method of choice for the

evaluation of marginal fit; the technique allows accurate *in vivo* measurement of marginal adaptation just prior to cementation and thus reflects clinical reality. The technique is ethically acceptable as the data collected is of direct clinical benefit to the patient without deleterious effects. The technique is easy, non-destructive, efficient to carry out, and relatively inexpensive.<sup>(12)</sup> Most investigators continue to use the criteria established by McLean and von Fraunhofer,<sup>(13)</sup> who after examining more than 1000 crowns, concluded that marginal gaps could range up to 120µm and be clinically acceptable. According to the data obtained in this clinical study, the null hypothesis stating that there is no difference in the internal adaptation and marginal fit of ceramic zirconia restorations obtained from both indirect extra-oral digitalization using conventional impression and digital intra-oral impression techniques is accepted. Regarding the effect of digitizing technique on the overall marginal gap of the study groups, it was found that the mean marginal gap size was 101.4 µm for the direct digital impressions (**group IDI**) and 106.2 µm for the indirect extra-oral digitalization using silicone conventional impressions (**group CIS**) The direct digitizing technique; recorded lower marginal gap which was statistically non-significant ( $P < 0.05$ ) to the other group. The better marginal fit of the intra-oral digital group could be attributed to the errors that might occur either during the steps of conventional impression making, pouring stone cast and/or during the extra-oral scanning of the stone models. In this study, in spite of following the manufacturer's instructions and a standard protocol for all steps of conventional impression making, still sources of inaccuracy are inevitable. First of all, no material has 100% elastic recovery.<sup>(14)</sup> In addition, in the conventional impression workflow, a stone model is created which is the basis for the construction of the crown, while in the digital workflow the crown is designed directly from the intra-oral scan without creating an intermediate model. On the other hand, deformation of the impression while removing from the prepared tooth might be another possible source for such inaccuracy.<sup>(15)</sup> Another contributing factor that might explain the better marginal and internal fitness of crowns fabricated from the direct

intra-oral scanning as opposed to conventional impression is the accuracy or the resolution of the intra-oral scanner as compared with the extra-oral scanner used to scan the stone models in the conventional impression group. CEREC Omnicam intra-oral scanner used in this study provides a color streaming technology which allows a continuous video capture with anti-shake property and emits white light with shorter wavelength than the blue light emitted by the inLab inEos X5 extra-oral scanner used to scan the stone model, which is less susceptible to bending, scattering and transmission by the scanned object.<sup>(16)</sup> The findings of this study are in agreement with Silva et al,( 2014)<sup>(17)</sup> , Tamer Abdel-Azim et al, (2015)<sup>(15)</sup> and Matthias Rödiger et al, (2016)<sup>(18)</sup> who all found that direct digitalization group showed better marginal fit than indirect digitalization group using conventional impression technique but without statistically significant difference. Our study is in contradiction with Syrek et al. (2010)<sup>(19)</sup> who found that significant difference in marginal discrepancies between restorations fabricated with conventional and digital intraoral impressions. According to their study, significant smaller marginal discrepancies were found within coping from direct digital scanners. This is may be due to the difference in the oral scanner being used (Lava C.O.S.) or type of restorations material (Lava TM crowns).The internal fit was reported to be a paramount importance in the success of the dental restorations. It should be highlighted that with all-ceramic restorations, poor internal adaptation could result in reduced resistance to fracture. For the internal gap, the clinically acceptable range differs from one article to another yet there is no standard protocol to assess the adaptation of dental restorations. This lack of standardization may lead to misinterpretation and limits the comparisons between results from different studies. One of the most important factors that might hinder comparisons among studies is the cement space previously predetermined by the software of the CAD/CAM system, scanner type, material of restoration and material processing. These factors differ from one study to another.<sup>(20,21)</sup> The results of the study shows differences in the mean of the internal

adaptation which was statistically non-significant ( $P < 0.05$ ) the mean internal misfit was  $244.2 \mu\text{m}$  for the direct intra-oral digital impressions (**group IDI**) and  $269.7 \mu\text{m}$  for the indirect extra-oral digitalization using silicone conventional impressions (**group CIS**). The higher internal misfit for the conventional impression technique may be attributed to difference in scanning techniques and inherent risks with conventional impression, such as expansion or contraction of impression material, a study by Alaei et al, (2015) <sup>(22)</sup> indicated that PVS impression material demonstrate a dimensional change by contraction of 0.24% after storage at  $23^\circ\text{C}$  for 24 hours. Also it was stated by Silva et al, (2012) <sup>(23)</sup> that gypsum type IV has linear dimensional change by 0.34% volumetric linear dimensional change after mixing and keeping to dry for two hours in room environment. The findings of this study are in agreement with S. Berrendero et al., (2016) <sup>(24)</sup> who found that there are no significant differences were found for any area between two study groups ( $P > 0.05$ ), although digital crowns showed a tendency towards a better fit than conventional group. In the present study, the best internal fitting quality for both fabrication techniques was detected at the measuring point at the axial wall (**CIS group**,  $213.4 \pm 67.5$  / **IDI group**,  $198.1 \pm 60.1$ ) this is in good accordance with the values reported by Ahrberg et al, (2016) <sup>(25)</sup> In the present study, the highest mean values for internal gaps were found in the occlusal area (**IDI group**,  $354.9 \pm 94.8$  / **CIS group**,  $400.1 \pm 125.7$ ). This is in good accordance with the findings of Pradíes G, et al, (2015) <sup>(1)</sup> and Boeddinghaus M, et al, (2015) <sup>(26)</sup> revealing the highest internal gaps in the occlusal area which may be due to Two concomitant phenomena called “overshoot” and “rounded edges” which occur during the scanning of angled regions due to the limitation in the scanner resolution could be responsible for the wider internal gaps. The results were in contradiction with Matthias Rödiger, et al, (2016) <sup>(18)</sup> who found that there are statistically significant better internal accuracy for direct intra-oral digital impression in the chamfer and occlusal area.

### Conclusions:

**1-Monolithic zirconia restorations** constructed with indirect digitalization using conventional impression or direct digitalization showed comparable marginal and internal fits.

**2-Monolithic zirconia restorations** fabricated from indirect digitalization using conventional impression or direct digitalization showed significant increase in miss fit at occlusal or incisal sites compared to the other marginal and axial sites. **3-The mean marginal adaptation and internal fit** in both groups were within the limits of clinical acceptability.

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