EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 70, 1515:1528, April, 2024

Print ISSN 0070-9484 • Online ISSN 2090-2360

Fixed Prosthodontics and Dental Materials

Submit Date : 23-12-2023 • Accept Date : 21-01-2024 • Available online: 10-04-2024 • DOI : 10.21608/EDJ.2024.257473.2843

NON-INVASIVE DIGITAL TECHNIQUE FOR EXAMINATION OF MARGINAL AND INTERNAL ADAPTATION OF DIFFERENT CERAMIC TABLE-TOPS

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ABSTRACT

Background: Lacking of proper marginal adaptation and improper cement seal of occlusal table-tops resulted in plaque accumulation, and marginal discoloration with subsequent caries progression, while increasing the internal gaps, lead to reduction of fracture strength of these restorations due to unequal load transmission and stress concentration.

Aim of the study: This study aimed to evaluate the effect of the use of various restorative CAD/ CAM materials on the marginal and internal adaptation of table- tops using a non-invasive digital method for evaluation of cement thickness space differences compared to the design cement setting.

Materials and methods: Sixty-eight human mandibular first molars were prepared to receive 1mm thickness table-top restorations. The restorations were divided into four groups according to the constructed CAD/CAM restorative materials (n=17): Group (ED) Lithium disilicate; group (CD) Zirconia reinforced lithium silicate; group (PZ) High translucent zirconia; and group (LU): Resin nano- ceramic. The prepared teeth were scanned with bench scanner and the STL files were saved to design the table-top restorations with cement gap setting of 30μm at margin and 50μm internally, the restorations were milled and prepared following the manufacturer's instruction for each material. A layer of light body silicone replica placed on the intaglio surface of each table-top and adapted over corresponding prepared tooth, after material setting; rescanning the prepared teeth with the replica. Geomagic software was used for superimposition of the two STL files (with and without replica; double scan technique), the thickness of the replica were calculated and compared to the previous cement gap setting.

Results: Marginal and internal gaps were statistically significant different from the cement setting in group ED, CD and PZ ($p \leq 0.05$) when compared with the LU that showed the least mean marginal and internal gap values (43.64, 72.95) and the closest to the cement gap setting.

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Conclusions: Hybrid ceramics LU showed the lowest marginal and internal discrepancies in relation to lithium disilicate, zirconia-reinforced lithium silicate and high translucent zirconia. The marginal and internal gap values of studied groups were of clinically acceptable range except for ED group.

KEYWORDS: Non-invasive, table-top, marginal gap, lithium silicate, zirconia

INTRODUCTION

Badly worn dentition is the main source of loss of vertical dimension which may be due to bruxism, erosion, or a combination of these factors that causes of severe tooth wear; it assumed to be treated with either full coverage restoration and may necessitate elective tooth de-vitalization and removal of healthy tooth tissues. [1]

Attrition refers to tooth structure wear as a result of teeth contact in either naturally or due to para-functional loads during masticatory process. [2] Elevation of occlusal vertical dimension is necessary for acquiring appropriate space of worn teeth restoration.[3] Whenever orthodontic intervention may be needed, it is impossible to obtain good outcome without increasing the vertical dimension, also raising the vertical dimension is needed with occlusion adjustments as in unilateral open bite after orthodontic treatment. [4]

Additional tooth preparation causes loss of a notable amount of dental tissues as well as those resulting from wear and/ or erosion, thus the choice of minimally invasive or the "no-preparation" restorations are the best options with increased amounts of lost dental tissue. [5]

Adhesive concepts were developed to support the minimal invasive protocol in rehabilitation of worn teeth surface utilizing either direct resin composite restorations[6], or table- tops for restoring the morphology and function of worn posterior teeth, using various CAD/CAM restorative materials, [7] that offer high quality restorations with lower surface defects or flaws, besides the high mechanical strength. [8]

Table-tops are considered the most basic form of overlays which are thin occlusal veneers of ≤1.5mm thicknesses, bonded mainly to enamel without axial extension beyond occlusal table and they are classified as (Type I), while (Type II) overlays are the most common in restoring teeth at (1.5 to 4mm) thicknesses, they are bonded mainly to dentin and could be accompanied with supragingival axial extensions as partial crowns, whereas (Type III) is similar to (Type II) but with an additional reconstructed dentin core, on the other hand (Type IV) overlays are used in restoration of pulpless teeth, each type of overlays had its specific indications and types of materials for its fabrication. [9]

The most suitable type of CAD/CAM ceramic materials for fabrication of indirect table- tops restorations is still unknown, however, Lithium disilicate was the most commonly used due to its adequate strength and excellent esthetic properties. It was also modified by the addition of zirconia particles for flexural strength improvement, although this does not mean increased fracture tolerance [10]. Occlusal veneers made of a hybrid CAD/CAM materials showed higher resistance to fracture under cyclic fatigue loads compared to other glass ceramic CAD/CAM materials, Schlichting et al.,[5], and Magne et al., [11]. Moreover, table- tops made of high translucency zirconia showed the highest resistance to fracture loads in comparison to reinforced glass ceramics and hybrid ceramics, according to Zamzam et al. [10]

Marginal and internal adaptation of different indirect restorations have a major role for their clinical success.[12] Compromised marginal adaptation resulted in accumulation of microbial flora and dental plaque, with subsequent microleakage that ends with secondary caries and periodontal problems. [12,13] In addition, the poor internal adaptation raises the risk of restoration failure due to fracture and retention loss. (12) Previous literature recommended the marginal gap value of 60-120 μm to be acceptable for clinical use. Literally, for CAD/ CAM ceramic crowns, the marginal gap values are usually lower than 90μm, (13) other studies reported acceptable CAD/CAM ceramic crowns marginal gap values that ranged from 50–100μm. (14,15)

As many factors affect the precision of all-ceramic restorations as manufacturing procedures, restorative materials, techniques of production, cementation protocols, aging and individual characteristics of the prosthesis, (16) restorations with perfect marginal and internal adaptation starts with the accurate impression and a properly fabricated master cast. (14) Conventional impression has some drawbacks as shrinkage, expansion, distortion, and may be uncomfortable experience for some patients. (17) In contrary, digital impression technique using intraoral scanners (IOS) for construction of an accurate three-dimensional computer-generated model of both maxillary and mandibular arches, have no distortion or lack of comfort to the patient. The digital system offers precise scans adjustments and bite analysis simultaneously. (13,18)

For determination of marginal and internal adaptation, gap values (cement layer thickness) could be evaluated by silicone impression replica, which is the most popular technique, but it may be inaccurate as a result of dentist's handling errors during the dispensing, mixing and managing of the material. (19) Digital non-invasive methods for estimation of thickness of the cement layer values as in dual and triple scans procedures, 3-D subtractive analyzing method, micro-CT, (20,21) stereomicroscopy, (22) point-matching scan protocols, (23) laser videography are also available. (24)

The aim of this study was to detect the effect of the use of various CAD/ CAM ceramic restorative materials on marginal and internal adaptation of table- tops using a non-invasive digital method (dual-scan method) for evaluation of cement thickness space differences compared to the design cement setting. The null hypothesis was that; no significant difference at marginal and internal adaptation of table- tops constructed by different CAD/CAM ceramic restorative materials.

MATERIALS AND METHODS

This study was approved by the Scientific Research Ethics Committee at the Faculty of Dentistry, Alexandria University (International No.: IORG0008839, Ethics Committee No.: 0806-11/2023). A Total sample size of 68 intact human mandibular first molars with comparable dimensions were selected for the study (n = 17 per group) based on the results of Loannidis et al (37) using G power version 3.1.9.4 to achieve a study power of 80% and α error of 0.05 , teeth were free from carious lesions and/ or old restorations, the molars were freshly extracted due to periodontal causes that were collected from the out- patient clinic of oral surgery division, faculty of Dentistry, Alexandria University. Disinfection of teeth with 1:10 diluted 5.25 % sodium hypochlorite for one week, and then keeping the teeth in a 0.9% saline solution during test period to prevent dehydration. (25) Every tooth was embedded in a self-curing acrylic resin 2mm below the cement- enamel junction using a split metallic copper mold. (10,26)

Pre-reduction additional silicon index was taken to be kept as a preparation guide for each tooth (Putty fast set, Ivoclar Vivadent, Schaan, Liechtenstein). Teeth preparations using high-speed diamond rotary instruments (TR-13, DIA-BURS, MANI Inc., Ut- sunomiya, Japan) were performed by a single well trained operator for standardization, the occlusal surface was reduced by 1 mm at the cusp tip and central groove, following the occlusal anatomy. (27,28) The peripheral enamel on the buccal axial wall was prepared by an inclined plane (hollow chamfer), (29) finishing and roundation of all

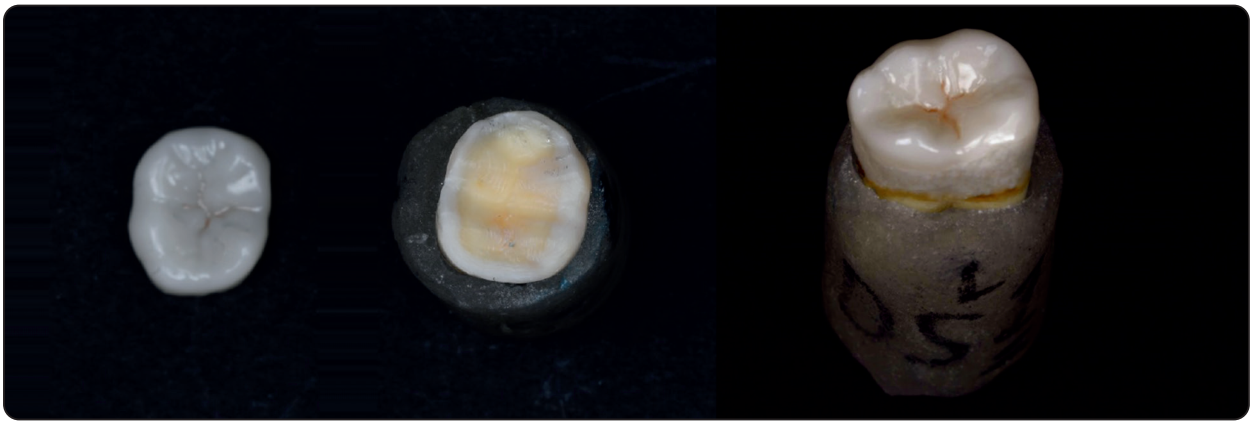


Fig. (1) Lower first molar tooth with table- top preparation and its corresponding restoration.

line angles was performed using Dura-White Stones (CN1 024-0201, SHOFU Dental INC, Kyoto, Japan) to create a smooth surface. [29] Then the amount of preparation was checked by the previously prepared silicon index. Figure (1)

The prepared teeth were divided into four groups each of 17 prepared teeth (n=17) according to different ceramic restorative materials for the fabrication of 1-mm thick occlusal table-top restorations as follows:

Group ED: Lithium disilicate ceramic table-tops; they were milled from IPS e- max.CAD (Ivoclar Vivadent AG, Schaan; Liechtenstein) (control group).

Group CD: Zirconia reinforced lithium silicate ceramic table- tops; they were milled from Celtra Duo (Dentsply Sirona, North Carolina; United States).

Group PZ: High translucent zirconia ceramic table- tops; they were milled from Prettau® Zirconia (Zirkonzahn; Italy).

Group LU: Resin nano ceramic table- tops, they were milled from Lava Ultimate CAD/CAM blocks (3M ESPE; USA).

The 68 prepared teeth were scanned using bench scanner (S600 ARTI, serial no. 002SC150019, Zirkonzahn; Italy), [30] operated by a dental technician. Digital scans were saved as standard tessellation language (STL) files and the suitable table- top restorations were designed (2017; 3Shape Dental System) to rebuild its corresponding prepared tooth. The design parameters were adjusted and the thickness of the cement spacer was set to be 30μm on the margin and 50 μm on the internal surface of the designed restoration, [31] all table- tops restorations were designed to have similar occluso-gingival thicknesses for standardization. The STL files data of each design were milled using five axial milling machine (KAVO Everest Engine; KaVo Dental Austria GmbH) unit, milling and preparation of veneers were done following the manufacturer's instruction for each restorative material. The table-tops were separated from their corresponding sprues, connection parts were polished, then tried for seating each on its corresponding preparation.

For assessing the adaptation of milled restorations a recent, non-invasive digitalized variety of impression replica technique, called the dual scan technique, explained by Lee et al., [32] to examine the adaptation of occlusal table-tops of different restorative material by measuring of the cement thickness space after milling. First scans were done for the prepared teeth and a second scans for the prepared teeth covered by silicone layer which simulate the cement thickness layer, a separating medium (Yeti Lube; Germany) was applied to cover

Fig. (2) Specially designed copper device used to stabilize the table- top to its corresponding preparation with a constant load of 50 N for 5 minute.

Fig. (3) Thin silicone replica on the prepared teeth which mimic the cement layer.

the intaglio surface of the table- tops, and a layer of light body silicone replica was applied (Fit Checker; GC; Belgium). Each restoration was accurately placed on the corresponding tooth and securely fixed to teeth using specially designed device with a copper bar that induced a constant force of 50 N for 5 minutes and seated along the long axis of the tooth, [33] the excess silicone material was carefully removed. Figure (2)

The restorations were detached, leaving a thin silicone replica on the prepared teeth which mimic the cement layer Figure (3). Another scan was done for the prepared teeth with attached cement layer analog (replica), Finoscan (FINO, Bad Bocklet, Germany) was used to spray the silicone surface prior to scanning to prevent reflection using the scanner's software (Zirkonzahn Scan, Zirkonzahn Modellier, v.6173, Zikronzahn; Italy). The dual scans were superimposed and overlaid over eachother, then they were analyzed using special software Geomagic control Inspection software (GOM, 2017 Hotfix 4, Braunschweig; Germany) for the analyses, thus files that were attained previously by scanning were superimposed using the scanner best-fit algorithm. [34,35]

Space between tooth margin and the restoration was called marginal adaptation. [36] The space between the remaining intaglio surface of the table- top and preparation was termed the internal adaptation.

A central virtual section was chosen in the GOM software illustrated as the symmetric bucco-lingual plane on the buccal and lingual surfaces. The measurements were made on symmetric fitting planes as follows: one point on each of the buccal and lingual cusp tip, a point at central groove, and one point at each buccal and lingual margin, results were read by only one of the authors for standardization of values [32,37] Figure (5).

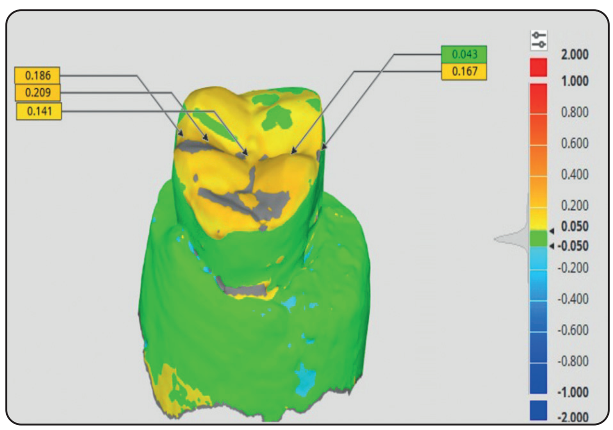


Fig. (5) Mid Bucco- lingual virtual section with one point on each of the buccal, and lingual surface buccal and lingual cusp tip and central groove for measurements in millimeters.

Statistical analysis

The statistical analysis of (ED, CD, PZ and LU) values of tested groups and effect on the scanned and superimposed cement space thickness for evaluation of the marginal and internal adaptation were showed in Table (1, 2). Fed the data to the computer, using IBM SPSS software package version 20.0 (Armonk, NY IBM Corp) to be analyzed. For continuity of data, data were tested for its normality by Shapiro-Wilk test. Quantitative data were analyzed as range of minimum and maximum, then means, standard deviations and medians were calculated. One way ANOVA test was used to compare between the studied groups, and Post Hoc test (Tukey) was used for pairwise comparisons. Significant differences between the obtained results was judged at 5%.

RESULTS

For marginal adaptation mean values of reading of one point buccal and one point lingual were calculated for all samples and statistically analyzed and compared showing that the highest mean values were recorded for group ED (191.63) followed by group CD (160.12), then group PZ (77.20), and the lowest mean value was recorded for the LU group (43.64). Statistically significant differences in cement gap thickness were found between ED and PZ groups, ED and LU groups, CD and PZ groups, CD and LU groups, and between PZ and LU groups Graph (1).

For internal adaptation the mean values of the reading of three points internally were calculated for all samples and statistically analyzed and compared showing that the highest mean values were recorded for group ED (231.94) followed by group CD (185.41), then group PZ (102.37), and the lowest mean value was recorded for the LU group (72.95). Statistically significant differences in cement gap thickness were found between ED and CD groups, ED and PZ groups, ED and LU groups, CD and PZ groups, CD and LU groups, and between PZ and LU groups Graph (2).

TABLE (1): Comparing the different groups according to marginal adaptation.

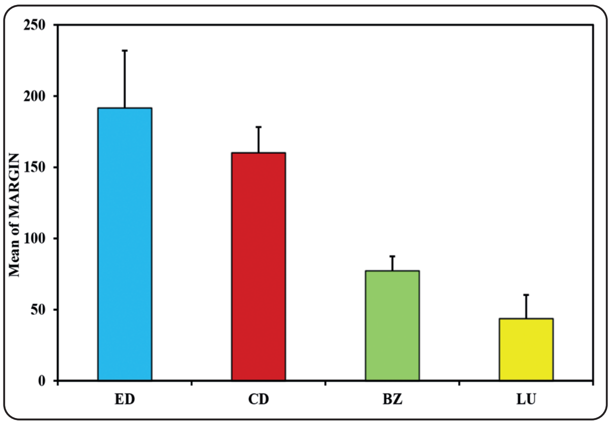
Marginal adaptation	ED (n=17)	CD (n=17)	PZ (n=17)	LU (n=17)	F	P
Min.	155.75	135.35	65.00	28.75		
Max.	286.60	200.85	99.00	90.50		
Mean	191.63 ^{a,b,c}	160.12 ^{a,d,e}	77.20 ^{b,d,f}	43.64 ^{c,e,f}	98.534*	<0.001*
± SD.	40.30	18.12	10.20	16.73		
Median	181.38	156.88	73.70	37.43		

SD: Standard deviation

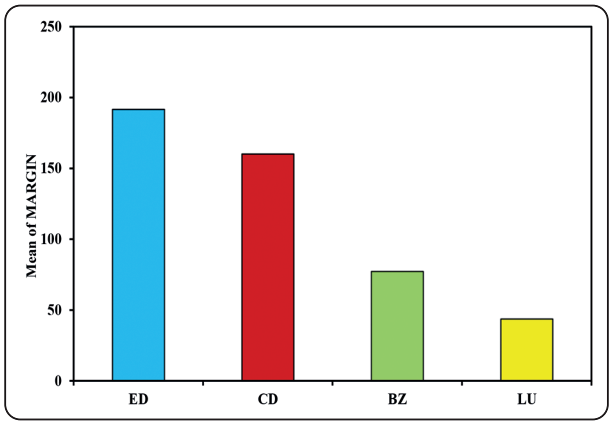
p: p value for comparing between the studied different sub-groups, *: Statistically significant at p ≤ 0.05

TABLE (2): Comparing the different groups according to internal adaptation.

Internal adaptation	ED (n=17)	CD (n=17)	PZ (n=17)	LU (n=17)	F	P
Min.	185.67	175.73	86.57	51.53		
Max.	280.10	200.03	124.30	93.07		
Mean	231.94 ^{a,b,c}	185.41 ^{a,d,e}	102.37 ^{b,d,f}	72.95 ^{c,e,f}	258.976*	<0.001*
± SD.	25.99	8.42	9.90	12.41		
Median	235.67	185.22	101.80	73.25		



GRAPH (1) Comparing the different groups according to marginal adaptation.



GRAPH (2) Comparing the different groups according to internal adaptation.

DISCUSSION

Recent progress in the restorative materials available in dental market, manufacturing technology, and advancement of adhesion protocols, enhanced the fixed dental prosthesis to be more conservative treatment. [5] Table-tops have been served as conservative alternation to full coverage crowns for compensation of advanced abrasive and/or erosive lesions. [4] Schlichting et al. stated that bonded ceramic restorations support the biomimetic principles of conservation and esthetics. [5]

In the present study, all table-tops were machined from CAD/CAM ceramic blocks or discs according to the available form of each material; CAD design is helpful in controlling the required restoration thickness and its anatomy. By standardization of cement space, this also helps in virtual standardization of the restoration's marginal and internal adaptation to the assigned tooth, also operator bias was avoided by exclusion of technical errors that occurs in dental laboratory by ill trained personals and fabrication procedures. [38] Cement gap internal thickness was designed to be 50μm as advised by Souza et al., who studied marginal and internal discrepancies compared to different marginal design of CAD/CAM all ceramic crowns and concluded that the range of acceptable adaptation-discrepancy ranged from 50 to 150µm. [39]

In addition, keeping a minimal cement thickness enhances the accurate insertion of the table-tops and allows insertion of an even thickness of cement layer with average values ranged from 25 to 50μm at the margin. [40]

Table-tops of 1 mm thickness were applied in the present study simulating many published literature, [41,42] As a systematic review by Albelasy et al. who concluded that lithium disilicate glass ceramic showed a satisfactory fracture strength results of the table-tops fabricated at a thickness of 0.7–1.0 mm. [43]

Marginal adaptation is crucial as cement exposure to the oral environment leads to subsequent cement dissolution and development of secondary caries. [44] Previous studies stated that however the size and shape of the preparation is a crucial factor influencing retention of indirect restorations, the internal adaptation is a second critical factor. [45,46] McLean & Fraunhofer evaluated 1,000 restorations during 5 year study and found that the largest acceptable marginal gap was 120 μm. [47]

Investigators have published variable evaluation methods which were used to evaluate the fit accuracy and adaptation by examination of marginal and internal gap. Previous review of Nawafleh et al, did not conclude recommendation for the best methodology. [48] Several methods promoted manual calculation of the gap thickness between the restoration and corresponding prepared surfaces of abutment. By the development of CAD/CAM techniques, digital aids are used for evaluation of indirect restoration adaptation. The double scan method was defined by Lee et al, it is a recent digital variation of the traditional replica technique which requires dual scans of the prepared teeth with and without a silicon replica layer that is equivalent the cement spacer, this technique could be easily used in both in-vitro and in-vivo evaluations. [34] In this study, a bench scanner was used because extra-oral scanner showed the best precision. [49] However, in the clinical situations; it is more convenient to use an intraoral scanner. In comparison to the triple scan methodology which is a clinically reliable technique that eliminates all sources of manual tracing mistakes which might happen, such as in the replica technique, on the other hand; the triple-scan method requires comprehensive and time-consuming scanning procedures. [34,50–52].

Many inherent factors affect the adaptation of CAD/CAM restorations: scanner precision, cement gap setting, software design, accuracy of the CAD unit, and the characteristics of CAD/CAM restorative material. [53,54] The advancement of recent CAD/ CAM technology encourages the usage of highly precise scanners supported by innovative designing software and precise milling machines. [55] The accuracies and trueness of scanners, [56,57] and precision of milling units have been studied in previous literatures. [58] Hence, CAD/CAM ceramic material properties have gained our interest thus accuracy of the CAD/CAM fabrication processing may affect adaptation of table- tops.

Multiplicity of CAD/CAM restorative materials has been implemented ranging from weaker feldspathic glass ceramics and leucite-reinforced glass ceramics to the higher-strength lithium di-silicate reinforced glass ceramics, zirconia with differing translucency properties, and hybrid ceramics. The mechanical properties of most these materials have been studied, [59] but in the literature there is less information concerning their marginal and internal adaptations; in addition, most of these studies have been restricted to either lithium di-silicate or zirconia. [54,60]

The standardized cement space settings of marginal and internal gap were considered in this study for evaluation of effect of material type on the marginal and internal adaptation of the table-tops; all the restorative materials used in the present study, the internal gap between restorations and their preparations except of ED and CD groups that detected by calculated virtual thickness of the silicone replica was around 150 µm. [39]

A previous study stated an ideal value for clinically acceptable marginal adaptation should be 100: 200 μm. [61] Another study by Nawafleh et al. considered marginal gap to be < 100μm. [48] So, the current results of marginal and internal gap for all tested groups except for the ED group providing an acceptable adaptation.

The marginal and internal adaptation were checked and measured in five points which were the buccal, lingual margins and under buccal and lingual cusp from the intaglio surface and at the central fossa. [37] Previous studies used another reference points to calculate the marginal and internal gap values, thus some used mesio-distal and bucco-palatal points, [32,36] while others used axial and occlusal points. [62–66] So a wide range of different measurements were observed (12–100,000 μm for internal gap and 4–80,000μm for marginal gap).

In our study; the mean internal gap measurements of all examined groups except for the LU group did not follow the designated cement spaces, this result may be accredited to the localization of pre-mature contacts with the intaglio surface that may modify the correct seating of table- tops and subsequently raise the internal and marginal discrepancies. [67]

This result was in accordance to other studies of Yildirim et al., [68] Prudente et al., [69] and Shim et al., [70] as they revealed an inverse relation between the marginal and internal adaptation spaces; and cement gap space with statistically significant differences among the different virtual cement space settings within different CAD/CAM restorative material as so increasing the cement spacer setting balances for the errors of the production process to decrease interferences with complete restoration seating and subsequent minimization of marginal and internal gap. [71]

In this study, all specimens showed lower marginal mean gap readings those for the internal gap means, this was in accordance with other studies, [72,73] which may be attributed to milling technique, as axial walls were milled through contact of the side of the milling bur, while the occlusal surfaces were milled with the end part of the bur tip.

Regarding present results; a statistically significant high mean marginal adaptation of ED and CD groups and the low values of marginal adaptation were recorded for PZ group and the lowest detected for LU group, results obtained from the study detected that the ED, CD and PZ groups recorded statistically significant higher marginal and internal gap mean values than LU group. Internal gap was nearly the same to the settings used for the cement space in both groups PZ and LU for marginal and internal gap values; while in the other test groups CD and ED, there were deviation from the settings in the range of 25% to 40% of the mean values. These may be attributed to manual preparation of the molar teeth that may cause minor irregularities on the geometry thus limit the milling of a complex fitting restoration surface so increased gap formation and impaired the marginal and internal adaptation. Other probable reasons of deviation from the designed cement space in group ED and CD could be the inherent properties of the materials.

Some negative reading was detected in the ED specimens during the superimposition of the scans giving high values of mean internal gap that not simulated the cement gap in the designed software, this result was in agreement with other previous studies. [68,69] This may be contributed by pre-mature contacts within the intaglio surface that interfere with accurate seating of the table-tops and subsequent rise of the marginal and internal discrepancies . [67]

Group CD table-tops fabricated from Celtra DUO, showed better marginal and internal adaptation than table-tops fabricated from e.max CAD in group ED. This result came in agreement with Ahmed et al., [74] Basheer et al., [75], and Abuhajar et al., [42], the microstructure of Celtra Duo, as manufacturer claims, presented increased edge stability, so offering satisfactory margins. [76] While inferior marginal and internal adaptation of e. max CAD resulted from dimension changes that happened during the crystallization firing stage as CD restorations were milled in a fully crystallized state, while ED restorations were milled in partially crystallized form.

Another factor explaining the significant difference between the CD and ED groups is the microstructure of both materials as; e.max CAD comprises nearly 70% fine crystals of lithium di-silicate, in addition to a 30% glassy needle crystals 1-2μm in length. While Celtra Duo consists of nearly 58% by volume crystals plus 10% Zirconium Di-oxide that enhance the unique fine- sized crystals (0.5 – 1 μm) in length. Differentiation of the crystal size in addition to glassy phase mixed in IPS e.max CAD was about 2000-4000 nm, which is 4:8 times more than found in Celtra DUO. [8,77]

The present results were in disagreements with El Sayed et al., [78], Taha et al., [79], and Abd Elmonam et al., [80] that explained the resemblance of composition and the slight differences in the microstructure of the materials used, [8,77] different in digitization or milling protocols and testing procedures might be an extra factor. Preis et al., [81] and Ashour Y et al., stated that the lithium disilicate showed improved total adaptation than zirconia reinforced lithium silicate. [82]

When comparing the ED to the PZ groups, the results showed that IPS e.max CAD is more detectable than high translucent zirconia in marginal and internal discrepancies resulted from the increased in dimensional changes taken place on firing. [83,84]

Resin nano- ceramic LU group displayed lower marginal and internal gap values than that for high translucent zirconia group PZ group without statistically significant difference in marginal adaptation and statistically significant difference in internal adaptation test and lower marginal gap values than zirconia-reinforced lithium silicate ceramic CD group with statistical significant difference, this may be correlated with the less brittleness and higher fracture strength of polymer-infiltrated Lava ultimate ceramic that encourage the fabrication of smooth, thin margin during milling process. [31,85,86] This result agreed with Salem et al., and Gungor et al., [87,88] as they stated that Hybrid ceramic restorations offered improved characteristics in marginal and internal adaptation than zirconia and lithium di-silicate restoration.

Regarding group PZ, the marginal and internal gap values greater than of LU group, this result may be explained as the high translucent zirconia was subjected to sintering process that may have an influence on adaptation as the zirconia as shrinkage occurred during the sintering process that may cause shrinkage due to contractions. [89,90]

As a conclusion based on the present results, the hypothesis was rejected as the marginal and internal gap spaces between table-tops and corresponding preparation was not similar and a significant difference were found in marginal and internal adaptation of table- tops milled from different CAD/CAM restorative materials.

The specific feedback of the machine frameworks production capabilities and the condition of milling burs and sintering ovens were limitations in this study. Another limitation was the need to spray the silicone replica with (Finoscan) to decrease the reflection during scanning. Scanning results indicating inaccurately thin cement gap because of the thickness of the spray coating, although Holst et al., [50] and Matta et al., [51] stated that the spraying with titanium oxide in order to decrease the scanning reflection was with no significance.

Clinical implication the obtained results from the present work referred that cement space adjustment during restoration designing could be decreased for group ED and CD to obtain a tighter adaptation.

CONCLUSION

1. Hybrid ceramic table- tops showed lower marginal and internal discrepancies than the other groups with statistically significant differences.
2. ED group showed the largest marginal and internal discrepancies when compared to other tested groups.
3. Marginal and internal gap values in the present study were within the clinically acceptable range except with ED, CD groups.

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