Clinical assessment of Marginal and internal fit of intra-radicular extention Design versus no extention design Endocrowns made of pressable Lithium Disilicate (Randomized Controlled Clinical Trial)

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DOI: 10.47750/pnr.2022.13.S08.512

Abstract

Aim: To evaluate the marginal gap and internal fit of pressable Lithium Disilicate with intra-radicular extention design versus no extention design restoring endodontically treated molars**.**

Material and methods: A total of tewnty-six patients (age 25-45 years) with endodontically treated molar teeth, indicated for endocrown restorations, were randomly allocated according to two groups according to the radicular extension of the restoration. Group (C) recieved endocrowns with no intra-radicular extension, while Group (EX) recieved endocrowns with intra-radicular extension. All endocrowns were constructed from pressable lithium disilicate (emax Ivoclar shade, VITA, Zahnfabrik, Germany, IPS e.max Investment Ring System VITA, Zahnfabrik, Germany). The marginal and internal fit of the fabricated restorations were determined using replica technique. the obtained data were tested for normaility and expressed as mean and standard deviation. Data were further analysed using Independent t-test.

Results: Mean marginal gap of Group C (37.31+-10.00) was statistically insignificant than Group EX (37.92+- 17.77). However, marginal gap of all tested samples of both groups was within acceptable clinical range (<120 μm). SPSS General Linear Model (GLM) two way analysis of variance (Two way Anova) showed that there was a highly significant difference was recorded within the position variant $P < 0.001$. *Mann-Whitney U* test showed that there was a statistically highly significant difference between axial internal gap and other internal gap readings for both group positions $P<0.001$ with the axial was the most lower reading.

Conclusions: Endocrown restorations with and without extensions both showed great levels of success in terms of marginal adaptation and internal gap.

Clinical implication: when restoring endodontically treated molar teeth, endocrowns with intra-radicular extension can be successfully used with similar success rates as conventional endocrowns.

Keywords: Endocrown; Intra-radicular extension; Replica; Lithium disilicate; Marginal gap.

INTRODUCTION :

Restoration of severely damaged endodontically treated teeth still represents a challenge. using post, core and a full-coverage crown was considered a typical protocol in restoring restore these teet, however, with the development of adhesive dentistry, more conservative restorations such as endocrowns were made feasible. endocrowns offered several advantages, such as more preservation of tooth structure, and reduced risk of root fracture, and ease of retreatment in case of endodontic failure. It was also time saving, as there is no need for the multiple steps involved in post cementation, core build up, and potential crown lengthening **(1**), Moreover, it offered the feaseability of restoring teeth with short, obliterated, dilacerated, or fragile roots.

Endocrowns achieved their retention utilizing the macro-retentive surface area of the pulp chamber walls and adhesive cementation micromechanically **(2)** many researchers aimed to increase the surface area for bonding to enhance restoration success, especially when very little remaining coronal tooth structure is available. Increasing the intra-

radicular extension approach was introduced to fulfill such purpose **(4)**, Increasing the retentive cavity, increased the endo-anchor, and hence the more the surface area available for adhesive retention and force dissipation, However, such approach could definitely affect the restoration retention and adaptation **(23)**.

little evidence was found in literature evaluating the effect of these designs on marginal and internal fit. Thus, the present study was intended to evaluate the effect of endocrown restorations with intra-radicullar extension in comparison to no extension on marginal and internal fit using Replica technique. The null hypothesis was that endocrown preparation design (intra-radicular extension versus no extension) would have no significant effect on the marginal and internal fit.

MATERIAL AND METHODS:

Ethics approval:

The present study was approved by the research ethics committee of faculty of dentistry, Cairo University.
Patients were rolled for making endocrown restorations of a root canal treated molar tooth between October - December 2019 were assessed for eligibility according to specified.

Sample size calculation:

A sample size was calculated based on a previous study [1] using a statistical software (PS-power and sample size calculations program version 3.1.2) adopting power of 80%. The minimum required sample size was 11 per each group which was increased to 13 to compensate for possible drop outs (Total number of sample size = 26 patients).

Inclusion and exclusion criteria.

A total of twenty-six adult patients, in the age older than 18 years old, with asymptomatic endodontically-treated molar. Tooth seeking definitive restoration were included in the present study. all patients had good oral and general health, able to withstand traditional restorative therapies. Patients with poor oral hygiene or bruxism were excluded from the study. endodontically-treated molars suffering from extensive cracks, fractures, increased mobility, with pocket depth > 3mm, or with deep subgingival margins (>0.5mm subgingival) that were considered to be non restorable were also excluded.

Randomization and blinding:

Patients were randomly assigned to each group using a computer-generated list of random numbers obtained using random.org software. The outcome assessors and the participants were blinded to the design employed while the operator was not blinded due to the difference in the tested preparation protocol between the tested groups.

Clinical procedures:

All teeth in both tested groups recieved the same occlusal preparation parameter, where 2±0.5 mm occlusal clearance was achieved using wheel diamond stone to create a 90-degrees occlusal butt joint margin, while maintaining the thickness of the remaining walls to 2±0.5 mm. Regarding the internal axial Preparation of the pulp chamber, the preparation was confined to removing pulp chamber undercut areas, while adjusting an axial divergence of 8–10 degrees utilizing a tapered diamond-coated stone all interior line angles were rounded. In group C a layer of a flowable composite (AMARIS flow, ,GmbH,Germany,Cuxhaven VOCO, Germany) was applied to the depth of the cavity to seal the orifices. the cavity floor was then smoothened to allow for the cavity depth of 3±0.5mm. However, in group EX ; an intra-radicular extension was performed in distal or palatal canals without the application of flowable composite figure 1. The intra-radicular extension was kept to 2 mm in depth and was standardized by using a special tapered cylindrical stone with the desired width and length. the extension was then slightly rounded and smoothened with tapered round end red-coded finishing stone. After finalizing each prepartion, conventional double-mix two-step impression was taken using addition silicone impression material (Panasil, (KG) Kettenbach GmbH Germany's Im Heerfeld Eschenburg). The master cast was poured and scanned using an extraoral scanner (Ceramill map 400 for extraoral scan, (AmannGirrbach AG, Koblach, Austria) to obtain virtual casts, upon which the endocrowns were designed using ExoCAD software version. CAD/CAM workflow was then proceeded , where the wax pattern of the designed restorations was milled from wax blanks (Aidite, RPD, Australia) in five axis milling machine (Ceramill motion2, Amann Girrbach AG, Koblach, Austria). The wax patterns were used for the construction of the final glass ceramic restorations (emax press, Ivoclar, VITA Zahnfabrik, Germany). According to the manufacturers instructions for heat pressing the final restorations were evaluated for the proximal contact strength before fabricating the replica. Adjustments for excessive contact were made to ensure complete seating **(21).**

Marginal and internal fit assessment:

The marginal gap and the internal fit were assessed using the silicon replica technique (**figure 4)**. This procedure involved injecting a light-body silicon impression material (Panasil, Kettenbach GmbH Germany's Im Heerfeld Eschenburg) into the pulp chamber, followed by completely seating the endocrown restoration (**figure 3**) over the prepared tooth, After polymerization endocrown was removed then putty silicon was mixed and pressed to pick up the light body layer. Using a sharp razor (Belgium , ZB 15) each replica was divided bucco-lingually and mesio-diatally to obtain four segments, , which were used for only one cut each to avoid dulling. Only two crossing segments

(mesiolingual and distobuccal) were scanned and measured (**figured 5**), since the other segments are thought to be mirror images of the first ones, Seven points have been identified on each segment (16); two points at the pulpal floor or intra-radicular extension (A), two points at the middle of the axial wall (B), two points at line angle between the floor (or intra-radicular extension) and the axial wall (C), and one point at the margin (D). The (A,B,C) points were used to assess the internal fit, while (D) point was used to assess the marginal integrity , A digital microscope (U500x Digital Microscope, Guangdong, China) with a 3 Mega Pixel resolution was used for image acquisition. which were then analyzed using an image analysis software program (Image J; NIH).

Statistical analysis:

Statistical analysis were performed using SPSS version 20 (SPSS Inc., Chicago, IL, USA). the level of significance was set at 5% ($p<0.05$). Descriptive data including Mean, standard deviation (SD), minimum and maximum values were calculated. Additionally, 95% confidenec interval were calculated, which indicated statistical difference based on lack of overlap of confidence intervals, i.e. absence of overlap meant statistical difference (22). Normality of data distribution was evaluated using Shapiro-Wilk test. Statistical significant differences of the obtained data were analysed using independent t-test or Mann-Whitney test, depending on the normality (21).

RESULTS:

According to descriptive statistics for marginal gap of the two group mean marginal gap of Group C (37.31+-10.00) was statistically insignificant than Group EX (37.92+- 17.77). However, marginal gap of all tested samples of both groups was within acceptable clinical range (<120 µm). Mean internal fit for Group C showed (91.87+-39.04) while for Group EX (91.58+- 44.04). 95 % Confidence interval for mean of EX group was 34.83 and 72.51 for lower and upper bound respectively. The C group range was between 37.16 and 71.97 for lower and upper bound respectively. Mean and standard deviation of marginal and internal gaps for both groups compared using Independent sample t-test, It showed that *t-value* of the marginal and internal gap of both designs were 5.63 and 6.20 respectively, It was found that there is a high statistically significant difference between both the marginal and internal gap sites $P<0.001$. SPSS General Linear Model (GLM) two way analysis of variance (Two way Anova) showed that there was a highly significant difference was recorded within the position variant $P < 0.001$. *Mann-Whitney U* test showed that there was a statistically highly significant difference between axial internal gap and other internal gap readings for both group positions $P<0.001$ with the axial was the most lower reading.

Marginal Gap (µm) descriptive statistical analysis:

Table (1): *Descriptive statistics for marginal gap of the two group.*

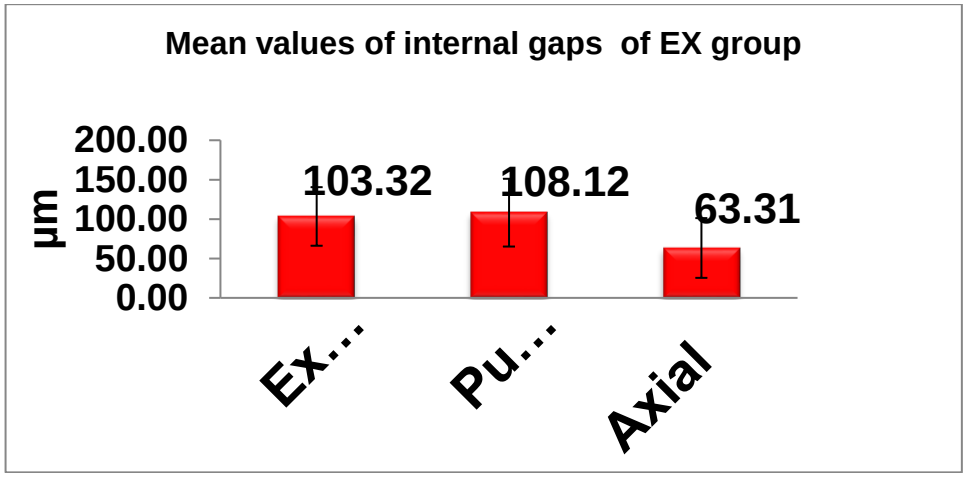
			95% Confidence Interval for Mean		
Group	**Mean**	**SD**	**Lower Bound**	**Upper Bound**	**P Value**
C	37.31	10.00	32.63	41.99	0.00000
EX	37.92	17.77	30.04	45.79	

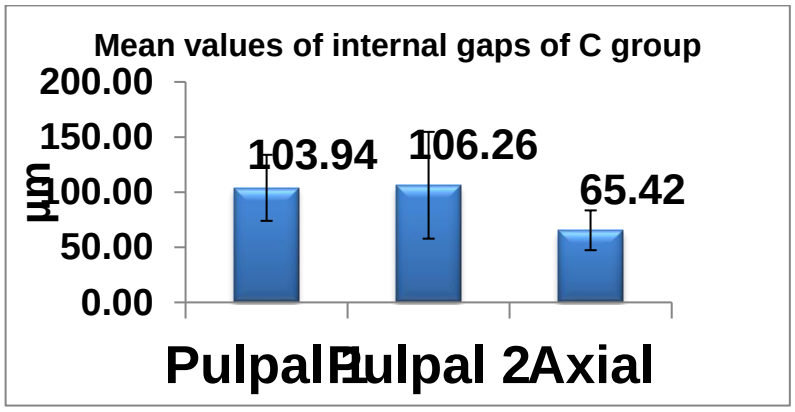
Table (2): *Independent sample t-test for comparing the marginal and internal gaps of intra-radicular extension group:*

Group EX	**Mean**	**SD**	**95% Confidence Interval of the Difference**		**T**	**P Value**
Marginal	37.92	17.77	**Lower**	**Upper**	5.63	0.00000
Internal	91.58	44.04	34.83	72.51		

Table (3): *Independent sample t-test for comparing the marginal and internal gaps of conventional design group:*

Group C	**Mean**	**SD**	**95% Confidence Interval of the Difference**		**T**	**P Value**
Marginal	37.31	10.00	**Lower**	**Upper**	6.20	0.00000
Internal	91.87	39.04	37.16	71.97		





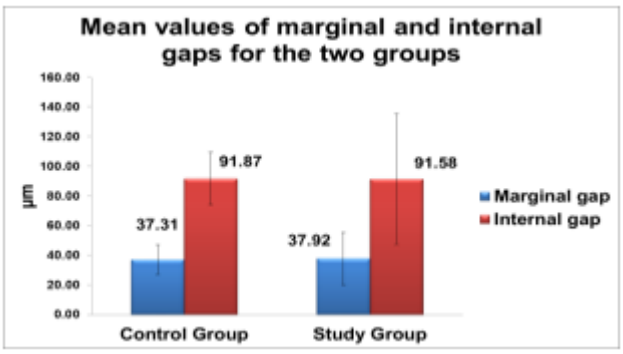


Fig 1: Intra-radicular extension by intensive diamond cylindrical stone

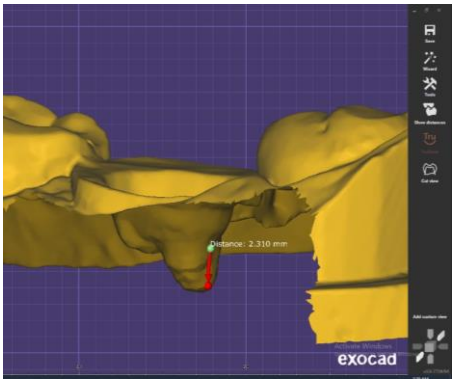


fig 2 Restoration designing proposal on software, measuring length and width of intra-radicular preparation

fig 3: Final restoration (intra-radicular extension design) after glazing

fig 4: Replica acquisition

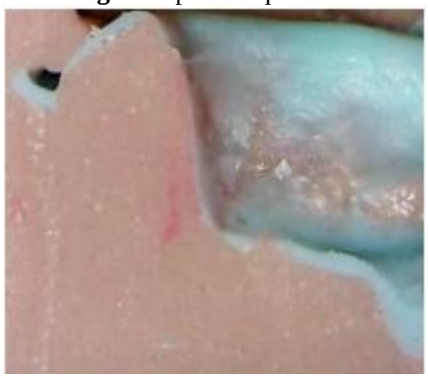


Fig5: Digital microscope image (1280 × 1024 pixels) of replica for (intraradicullar extension design)

DISCUSSION

Dental aesthetics and minimally invasive dentistry have gained a lot of interest nowadays. The significance of maintaining tooth tissue and the advancement of dental materials have led to the introduction of new concepts for tooth restoration that reject harsh macromechanical methods **(Biacchi et al., 2013).** Thus, the current study was conducted to test endocrown restoration, being one of the conservative approaches in fixed prosthodontics, restoring endodontically treated molars. Patients with poor oral hygiene, Parafunctional habits or active periodontal conditions were excluded from the study to avoid any confounding factors that might affect the results of present study (**Alharby et al., 2018).** Patients randomization and blinding was performed to eliminate the risk of selection bias and provide more reliable

results **(Jakobsen and Gluud et al., 2013).** The study tested two designs of endocrown restorations, The first design was the conventional design with butt margin and no radicular extension, which served as control as it is the most commonly used design in practice. The other design possessed a modification of the conventional design planned by extending the restoration into the widest canal in molars aiming at providing greater surface area for adhesive retention, improved masticatory force transfer to the root, and ultimately improve restoration success (**Pedrollo Lise et al., 2017).** The preparation floor was sealed with flowable composite in conventional group only to flatten the pulpal floor for better stress distribution while for extension design no canal obliteration was done to gain the advantage of canal extension without affecting the it's length. All sharp line angles were rounded in both groups to avoid any stress concentration. The internal cavity was tapered by 8 degrees in both groups as recommended for endocrown preparation, to facilitate the restoration seating without interference and facilitate the adhesive cement escape (**Dartora et al., 2018**)**.** Intra-radicular extension was kept at 2 mm in depth to make use of the widest portion of the root canal, and at the same time avoid over extension into the root canals, which might cause accidental perforations or unnecessary thinning and subsequent weakening of the roots in the attempt of providing adequate space to accommodate for the ceramic restoration used. After finishing of the preparation the access cavity was filled with Polytetraflouroethelene tape (PTFE) or as traditionally named (Tephlon tape) by compacting the material about two thirds of the whole depth then a provisional restorative filling is placed over till try-in had being finished by the lab. When compared to other regularly used temporary restorative materials, PTFE demonstrated an adequate sealing ability. In addition, it makes it easier to remove temporary materials while leaving no residue on cavity walls (**Olcay et al., 2015**), **(Fernando Pessoa, n.d., 2018).** In this study we used the two step addition silicon impression technique (panasil soft , Kettenbach), due to it's high dimensional accuracy, easy recording fine details, high flowability criteria and being able to be poured after few days (**Mahboubi et al., 2020**). The master cast was then poured and scanned using an extraoral scanner. This provided highly accurate replica for the cast upon which the restoration will be easily and efficiently designed. such technique became widely used nowadays to make use of the advantages of digital dentistry whenever intraoral scanners were not feasible. Ceramill map 400 extraoral scanner was selected due to its high performance and clinical accuracy. Try in was made by the aid of 3D printed PMMA resin and assessed in terms of marginal fit, stability, occlusion, which is used later on as an provisional restoration till receiving the final endocrown by cementing it using a non-eugenol, acrylic-urethane polymer-based temporary cement, it was temporarily glued **(Tribst et al., 2021).** Then, milled wax was created using the same software design to lessen the possibility of human errors**.** Cement space was set to 50 microns, to achieve proper gap and intimate fit at the same time between the tooth and the restoration; (**Elalem, et al., 2019)**. The final restoration was fabricated from lithium disilicate ceramic material (emax press). Such material was preferred in endocrown fabrication as it provided high success rates due to their enhanced mechanical strength, strong bonding strength, and superior esthetic appearance. Pressing was used to fabricate the number of needed restorations offering high strength and marginal fit comparable to that obtained by milling (**Dartora et al., 2018**). Before cementation, the fit of the endocrowns was evaluated using Replica technique. such technique provided a quantitative, non-invasive, reliable maneuver for measuring marginal and internal fit of the restoration to the tooth structure **(Abdullah et al. 2016**). During cementation selective enamel etching was performed to enhance marginal integrity **(Souza-Junior et al. 2012**) cementation was performed using a total etch dual cured adhesive resin cement, where total-etch cements showed superior marginal integrity to that of self-etching materials. In addition, being dual cured ensured complete setting of the cement even at the deepest parts of the preparation where the light curing beam couldn't reach especially in the radicular extension portion. Each replica was divided into four parts. Then only two contralateral segments were measured as the other two were considered as a mirror readings for the first ones **(Ribeiro et al., 2015**). An overall fourteen readings for each endocrown replica was collected, (two for margin and twelve for internal fit). The replica technique was the technique of choice as it's a quantitative non-destructive and valid for assessing internal fit and marginal integrity (**Abdullah et al., 2016**). Regarding the marginal gap assessed using the replica technique: the results failed to reject the null hypothesis where there was no significant difference in the marginal gap between the tested groups, the recorded marginal gaps were within the acceptable clinical range (less than 120 μm) as defined by (**Meshreky et al 2020)** with the **intra-radicular extension *group*** showing a greater marginal gap mean value that was statistically non-significant (37.92 m) than the no extension group (37.32 m). These results might be due to utilizing the CAD technology in the designing which allowed a high accurate restoration , it might also be due to utilizing the pressing technology in manufacturing the restoration which allowed an appropriate marginal adaptation also keeping the cement space to the minimal acceptable value might have contributed in this result. These findings were consistent with a research conducted by (**Soliman, Kholoud 2019)**, in which the E max CAD shown the lowest values (19.65 10.2) before to thermal aging and the Celtra DUO displayed the lowest values (32.21 7.88) during thermal ageing. Also the results came in **agreement with** (**Soliman, Kholoud, 2019)** that revealed reduced marginal gaps, it was shown that e.max lithium disilicate restorations made using the Press approach have marginal gaps that are considerably less than those made using CAD methods. A discrepancy of the size of the cutting tools, with respect to tooth preparation geometry may cause maladaptation with subsequent inferior marginal fit of the computer milled ceramic restoration. Our study results were also in **agreement with** (**Elalem et al, 2019),** that showed the marginal gap in the butt joint design of E-Max press endocrowns group were within the clinical acceptable range (73.49±5.29 μm). Our study results were also **against (Sağlam et al., 2021)** Who noted that the E-Max press endocrowns' marginal gap was 122.49± 28.37 mm. The manual process used to create wax patterns may have resulted in different results, and this method is subject to human error and inappropriate handling. Regarding the internal fit there was no statistically significant difference between the tested groups, where the internal gap mean value for the **intra-radicular extension *group*** in our study was (103.32± 37.18μm) at the extension side and (63.31 ± 37.91 μm) at the axial side. While for control group it was (103.94

± 29.96μm) at pulpal and (65.42 ± 18.04 μm) at the axial side, This was in **agreement with** a study held by (**Elalem et al., 2019)** that showed the internal gap in the butt joint design of E- Max press endocrowns were within the clinical acceptable range (83.05±11.72 μm). Our study was also in **agreement with** (**El Ghoul et al., 2020)** and (**Hasanzade et al., 2020)** where E- Max CAD endocrowns internal gaps at the axial sites were 90.5 ±18.9 μm, and 70.18 ±14.03 μm respectively while internal gaps at the pulpal sites were 141.6 ±20.1 μm and 102.62 ±26.3 μm respectively. The difference in results at the pulpal site might be due to the milling the restoration rather than pressing it where the later had lesser sintering shrinkage, moreover, Internal gap especially the axial depends on the amount of cement gap which decrease when it is decreased, it also depends on the amount of occlusal taper which increase when taper is increased (**Hasanzade et al., 2020).** The difference in the internal gap values between different points reading at axial and other measures being axial was the lower might be attributed to the dimensional change following pressing, variations in thermal temperature associated with staining and glazing, and these results were in agreement with (**Elalem et al., 2019).** Our study was partially in agreement with **(Abdullah et al., 2016),** who assessed how preparation depth and intra-radicular extension affected CAD/CAM endocrown restorations' marginal adaption and internal fit found that intra-radicular extension of the preparation had a detrimental impact on both.

CONCLUSIONS

1. Within the limitations of this study, regarding the marginal and internal gap of both designs there was no difference that is statistically significant.
2. Endocrown restorations with and without extensions both shown a great levels of success in terms of marginal adaptation.
3. Endocrown with intra-radicular extension proved to be a valid alternative to conventional endocrown.

RECOMMENDATIONS

It is recommended to conduct more studies for a longer period of time to test the effect of new materials such as hybrid and resin-based ceramics on the marginal and internal fit of the two tested designs. also testing modifications of the tested design to increase the intra-radicular extension can be useful.

CLINICAL IMPLICATION:

When restoring endodontically treated molars, endocrowns with 2mm intra-radicular extension in the widest canal can be used successfully in terms of marginal and internal fit.

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