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EFFECT OF PREPARATION DEPTH ON MARGINAL ADAPTATION OF ANTERIOR TEETH RESTORED BY ENDOCROWNS AND POST RETAINED CROWNS (IN-VITRO STUDY)

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ABSTRACT

Aim: To compare marginal adaptation (MA) of IPS e.max computer-aided design (CAD) and press endocrowns with different preparation depths (2mm and 5mm) and crowns retained by post and core.

Material and Methods: Thirty-six intact maxillary central incisors were practiced. Teeth were categorized into two major groups (n=18) according to the material fabrication methodology; I: computer aided design/ computer aided manufacturing (CAD/CAM) technique and, II: Pressing technique, the major groups were then subdivided into three subgroups (n=6): S1: crown held by post and core, S2: short endocrown with 2mm inter-radicular depth, and S3: long endocrown with 5mm inter-radicular depth. Restorations were cemented with resin cement and exposed to thermo-cyclic loading (5000 cycles), followed by MA evaluation. Data were gathered and subjected to statistical analysis utilizing a two-way ANOVA test.

Results: The results showed significantly larger marginal gap values in group I (IPS e.max CAD) compared to group II (IPS e.max Press), across all designs. Marginal gap values of different designs using CAD/CAM technique showed significant differences between designs, emerged ($p=0.036$), with S3 (75.4±5) showing significantly larger marginal gap values than the other designs (S1: 65.5±7.7 and S2: 72.7±5.2). Marginal gap values of heat- pressing group showed statistically significant differences between different designs ($p<0.001$), with S3 consistently showed significantly larger marginal gaps values (54.5±5.6) than both S1 (42±2.7) and S2 (45.1±3.1).

Conclusion: All groups showed clinically accepted MA results. Restorations fabricated by heat pressing technique showed a higher MA than those fabricated by CAD/CAM technique. Differences in preparation designs depths have a statistically significant impact on MA of restorations both before and after cementation.

KEYWORDS: Endocrown, Endodontically treated maxillary central incisors, Marginal Adaptation, IPS e.max CAD, IPS e.max Press.

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INTRODUCTION

It is important to understand that the biomechanical properties of endodontically treated teeth (ETT) are different from those of live teeth. These include diminished nociception, dentin aging brought on by endodontic irrigants, and the loss of the natural structural strength provided by the pulp and marginal ridges.[1-2]

It is also significant that, anterior teeth experience an oblique pattern of loads, which makes them more prone to fracture.[3] It is remarkable that prosthetic problems are the primary cause of anterior tooth extractions, making ETT restoration difficult, with the selection of the right restorative technique and materials being crucial.[4]

One of the possibilities for ETT rehabilitation with significant coronal destruction is endocrowns.[5] In a prosthetic crown composed of ceramic or resin-based composites (RBC), the coronal section and the supporting core are notably integrated into a single unit known as "monoblock" Since macro and micromechanical retention are accomplished by an anchoring effect in the inner part of the pulp chamber and by adhesive cementation, respectively, endocrowns do not require an intracanal post or additional root canal preparation, in contrast to conventional crowns supported by cast metal posts or glass fiber posts (GFP).[6]

Additionally, compared to traditional restorations, endocrowns require a less complicated and invasive preparation procedure, which cuts down on treatment expenses and clinical time.[7]

In cases of severe ETT destruction, the most common method of tooth rehabilitation has historically involved combining glass ceramic crowns with intra-canal retainers.[8-9] However, GFP or cast post and cores can only retain the restoration without enhancing tooth strength,[3,10] and intra-canal retainers may result in additional removal of sound tissue, raising the risk of tooth fracture.[7]

The group of glass-ceramics, which have been used extensively for a long time, is a significant topic of interest in ceramic materials.[11-12]They are a desirable, distinct group due to their ongoing improvements in mechanical characteristics, improved microstructure, and various processing methods.[13]

CAD/CAM technology has emerged as a popular substitute for traditional processing techniques.[14] The combination of this processing approach and the ongoing development of all ceramic materials utilized with this technology led to complete comprehension and assistance in the clinician's choosing process.[15] The heat pressing method, which has been effectively applied for a long time to create pressable ceramic restorations, is another widely utilized processing technique. Glass ceramic ingots are heated to facilitate pressure flow into a lost wax mold.[16]

Success and superior quality of the restoration are primarily governed by three factors: marginal adaptation, fracture resistance, and aesthetics. Endodontic irritation, microleakage, cavities, and plaque accumulation are all consequences of inadequate marginal adaptation that can lead to restorative failure. Marginal adaptation accuracy is measured by the gap between the preparation end point and the restoration fitting surface. Among the methods used to evaluate this are laser videography, silicone replicas, microscopy, and micro-computed tomography; direct microscopic examination is the most frequently employed of these because to its non-destructive nature and reproducibility.[17]

Examining the effects of various endocrown designs, such as ferrule inclusion with varying intra-radicular depths in contrast to the conventional post and core, on the restoration's marginal fit is what makes this study novel.

Thus, comparing the MA of IPS e.max CAD and press endocrowns with varying preparation depths (2mm and 5mm) and crowns held by post and core is the goal of the current study.

MATERIALS AND METHODS

Study Design

A randomized, comparative, and experimental in-vitro investigation was conducted in conjunction with this study.

The study was accepted by the Minia University, Faculty of Dentistry's Research Ethics Committee (RHDIRB2017122004) with protocol number (1/6/2022). This investigation began in 2022 and ended in 2024.

Sample Size Calculation

According to a study by (Waaz S. 2020)[18], with a power of 80% (β=0.20) and a level of significance of 5% (α error acceptable =0.05), the required sample size is 6 specimens (n=6) per subgroup (number of subgroups = 6), resulting in 18 specimens per primary group, for a total of 36 specimens. The sample size was calculated with the G*Power version 3.1.9.4.

Specimens Collection and Randomization

A thirty-six, undamaged human maxillary central incisors that had been extracted recently for periodontal reasons. The study included maxillary central incisors with straight, fully formed roots, without carious cavities, cracks or fractures, and approximately identical dimensions (7±1mm mesio-distally, 6±1mm labio-palatally, 10±0.5mm coronal length, and 15±0.5mm root length). Teeth having bent roots, open apexes, carious cavities, or fractures were excluded.

Teeth were ultrasonically cleaned, disinfected for 10 minutes with a 5.25% sodium hypochlorite solution, and then stored in distilled water at 37°C to prevent dehydration. To guarantee a fair sample distribution, a computer-generated random number list was utilized to divide specimens into two primary groups based on construction method (www.randomizer.org). Using the same procedure, each group was randomly and evenly divided into three subgroups: (S1) for crowns retained by post and core, (S2) for short endocrowns, and (S3) for long endocrowns (n=6) based on the restoration design. The same operator carried out each procedure.

Specimens Grouping

The specimens were randomly assigned to one of two basic groups based on the building method:

Group I: CAD/CAM technique (*n*=18)

Group II: Pressing technique (*n*=18)

Each major group was then devided into three subgroups (n=6) based on design:

The first subgroup: **S1:** crown held by glass fiber post and core.

The second subgroup: **S2:** short endocrown (2mm depth).

The third subgroup: **S3:** long endocrown (5mm depth).

Endodontic Treatment

Endodontic treatment was conducted on all teeth by a single operator who used identical procedures and instruments to maintain uniformity.

A size 10 K-file (Mani, Tochigi, Japan) was carefully introduced into each root canal, reaching the apical foramen. A visual check found that the working length was 0.5 mm shorter than the measured length of each tooth's root, so a periapical X-ray was performed to validate the working length. Endodontic treatment was carried out using rotary files (Protaper, Universal System, Dentsply Sirona, Switzerland) up to size F2. 5.25% sodium hypochlorite and EDTA were utilized to irrigate the canals during the mechanical preparation process. Following instrumentation, paper points were used to dry the root canals.[18]

A resin-based sealer was used to obturate the canals (Ad seal, Meta Biomed, Korea) and gutta percha of proper size (Aurum Pro, Meta Biomed, Korea) was consequently employed to seal the root canals. Excess gutta percha was reduced to 1 mm below the CEJ. Canals was sealed with temporary filling restoration (Cavit, 3M ESPE, Germany), specimens were then placed in 37° C distilled water for 48 hours to achieve complete setting.

Preparations

To maintain standardization, all teeth were prepared by a single clinician using the same processes and tools.

Next to endodontic treatment procedure, to aid in specimen preparation and testing processes, teeth were set in auto-polymerizing acrylic resin (Acrostone, Egypt) 2 mm below the CEJ using a plastic mold. Then, teeth were cut horizontally 2mm above the CEJ using a coarse diamond disc (Microdent, Monsey, New York, USA) with copious water. The remaining coronal length from the CEJ was measured by a periodontal probe.

Preparation of Crowns Retained by Post and Core;

A universal Gates Glidden drill (Nordin Gates Reamers, Switzerland) was used to remove gutta percha, leaving 3-5 mm to guarantee a good apical seal.[18]

After removal of gutta percha, a glass fiber post drill (Pentron, Kavokerr, USA) was utilized to drill the post space to the necessary length (12 ± 1 mm). To confirm the accurate post's length and diameter, X-rays were taken after the post was selected and positioned in the canal. Self-adhesive resin cement (RelyX U200, 3M ESPE) was used to bond the posts in their corresponding canals, the extruded section of the post was separated, leaving only 2mm of the post coronally to allow core retention.

A clear template over resin core was used as a mold for all specimens of subgroup S1 in order to standardize core build up for all specimens. All of the teeth were etched (MetaTM Etch, Meta Biomed, Korea), and a bonding agent was used (BISCO Inc., USA).

The build-up material (Build-ItTM, Pentron, Kavokerr, USA) was inserted in the template, which was then positioned over the prepared tooth to ensure core build-up homogeneity.

Each specimen was prepared with full coverage ceramic using a uniform process. All specimens were prepared using a high-speed handpiece (Sirona T3 racer, Germany), to create a 1mm deep chamfer finish line which was placed 1mm above the CEJ in the preparation design. A total of 6° convergence should be obtained.

Endocrown Preparation;

To remove undercuts with an 8° coronal divergence, the pulp chamber was prepared with a tapered round diamond bur. Extension depths of 2 mm for short endocrowns and 5 mm for long endocrowns were achieved utilizing Gates Glidden drills and fiber post drills, with a periodontal probe used to validate the depth. The angles of internal lines were smoothed and rounded. One millimeter deep chamfer finish line, was produced to form the ferrule design, and a total taper of 6° was achieved.[19]

Restorations Fabrication

IPS E.max CAD Restorations

A CEREC CAD/CAM technology was used for scanning (Cerec Primescan, Dentsply, Sirona, USA), designing (Dentsply, Sirona, USA) and milling (CEREC MC XL, Dentsply, Sirona, USA) all specimens of group **I** by using IPS e.max CAD blocks (Ivoclar vivadent, Switzerland). After milling, all restorations were crystallized and glazed (Cerec speedfire, Dentsply, Sirona, USA), then each restoration was tried on its corresponding specimen. (Fig. 1)

IPS E.max Press Restorations

The identical inLab scanner that generated group (I) was used to scan all specimens in group (II). To ensure standardization, the wax patterns were

Fig. (1) IPS e.max CAD endocrown

produced and machined digitally, followed by the addition of sprues and the investment of crowns and endocrowns with IPS Press Vest material (Ivoclar, Vivadent, Switzerland). The restorations were then made with IPS e-max glass ceramic ingots (IPS e.max Press, Ivoclar vivadent, Switzerland), following the manufacturer's guidelines. Finishing was performed in accordance with the manufacturer's recommendations, using a fine diamond disc and grinding tools.[20]

Cementation Procedure

Prepared teeth were etched for 30 seconds with 37% phosphoric acid (Meta Etchant, Meta BioMed, Korea), rinsed completely, and air-dried.

Bonding agent (All bond Universal, Bisco Inc., USA) was applied, air thinned and then light-cured for 20 seconds.

The fitting surface of each crown and endocrown underwent surface treatment consistent with the manufacturer's references prior to restorations bonding. The inner surface was etched for 60 seconds using 9.5% hydrofluoric acid gel (BISCO-Schaumburg, USA). Subsequently, restorations were cleaned with water (Dental chair Roson, China), then air stream was used for drying.[21] Silane coupling agent (BISCO-Schaumburg, USA) was applied for 30 seconds, followed by air dryness.

Dual-cured resin cement (Rely X Ultimate, 3M, Seefeld, Germany) was used for bonding. Initial curing for 2 seconds took place to allow removal of excess cement using sharp explorer, followed by final curing for 40 seconds for each surface. A specifically built loading machine with a 5 Kg load was placed vertically over the restorations, followed by an initial curing for only 2 seconds to allow extra cement removal, finished with a 20-second curing period on each surface.

Thermal Aging

All specimens were stored in distilled water at 37°C for two days prior to the thermo-cyclic loading technique. An automated thermal cycling device (Robota BILGE,Turkey) was used to mimic oral cavity temperature variations, by subjecting all specimens for 5000 cycles between 5°C and 55°C, with a dwell time of 20 seconds.

Marginal Gap Measurements;

Each specimen was photographed using USB Digital microscope with a built-in camera. The digital image analysis system (Image J 1.43U, National Institute of Health, USA) was utilized to measure and analyze the margin gap width. The marginal gap of each specimen was measured before and after cementation. Then the data obtained were collected, tabulated and then subjected to statistical analysis. (Fig.2)

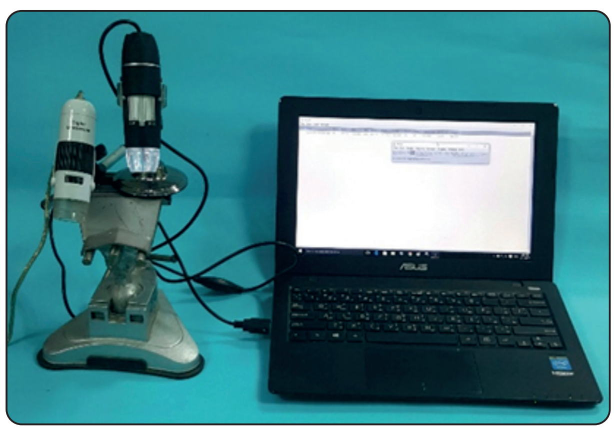


Fig. (2) USB Digital microscope with a built-in camera

Statistical Analysis

All descriptive data were collected and categorized, and the normality of the data distribution was determined. Subsequently, all data were analyzed using two-way ANOVA, followed by Tukey *post-hoc* test (SPSS 15.0, SPSS Inc., Chicago IL, USA).

RESULTS

1- Comparison of marginal gap before and after cementation according to method of construction across all designs;

The results show significantly larger marginal gaps in group I (IPS e.max CAD) compared to group II (IPS e.max Press) both before and after cementation across all designs. Indicating that the cementation process consistently increases marginal gaps regardless of material choice.

For S1 (post retained crowns); group I recorded statistically larger marginal gap than group II, both before (52.5±3.4 vs 31±3.4, p<0.001) and after cementation (65.5±7.7 vs 42±2.7, p<0.001).

S2 (endocrowns with 2mm extension depth), showed similar patterns to S1. Group I significantly showed larger marginal gaps than group II, both before (56±5.7 vs 30.8±3.7, p<0.001) and after cementation (72.7±5.2 vs 45.1±3.1, p<0.001).

S3 (Endocrowns with 5mm extension depth), group I showed significantly larger marginal gaps than group II both before (60.6±6.5 vs 38.8±5, p<0.001) and after cementation (75.4±5 vs 54.5±5.6, p<0.001).

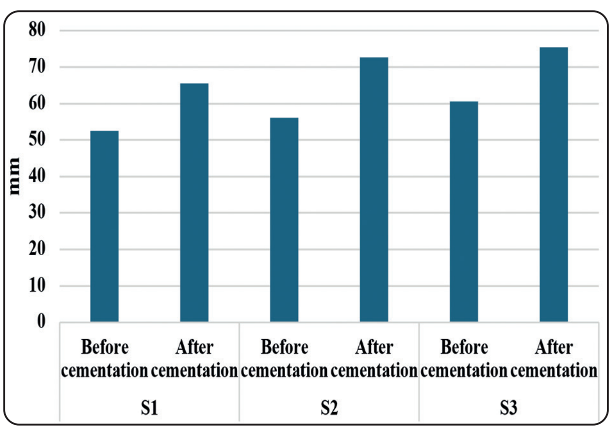
TABLE (1) Intergroup comparison (group I) of marginal gap values for different preparation designs:

				Design			P-value
				S1	S2	S3	
				N=6	N=6	N=6	
Marginal gap	**IPS e.max CAD**	**Before cementation**	*Range*	(47.7-58.4)[a]	(50.6-66.5)[a]	(52.2-69.3)[a]	*0.060*
			Mean ± SD	52.5±3.4	56±5.7	60.6±6.5	
		After cementation	*Range*	(50.6-70.7)[a]	(67.7-82.2)	(66.8-80.5)[b]	***0.036****
			Mean ± SD	65.5±7.7	72.7±5.2	75.4±5	

One Way ANOVA test for comparison of quantitative data between the three groups followed by post hoc LSD analysis between each two groups.

Superscripts with different small letters refer to significant difference between each two groups.

****: Significant level at P value < 0.05***



Graph (1) Marginal gap values of different preparation designs, before and after cementation in group II (IPS e-max CAD)

2: Comparison of marginal gap values of different preparation designs, before and after cementation Using IPS e-max CAD; (Table 1)

Comparison of marginal gaps between different designs in group I (IPS e-max CAD). Before cementation, there were no significant differences between designs (p=0.060), with means ranging from 52.5±3.4 to 60.6±6.5. However, after cementation, significant differences emerged (p=0.036), with S3 showing significantly larger gaps than the other designs. This suggests that the cementation process affects different designs differently when using CAD material. (Graph 1)

3- Comparison of marginal gap values of different preparation designs, before and after cementation of group II (IPS e-max Press); (Table 2)

Examination of marginal gaps between different designs using IPS e.max press. Significant differences were found both before (p=0.006) and after cementation (p<0.001). Design S3 consistently showed significantly larger gaps than both S1 and S2, as indicated by the different superscript letters. This suggests that with pressing technique, the 5 mm extension design (S3) consistently results in larger marginal gaps compared to other designs, both before and after cementation. (Graph 2)

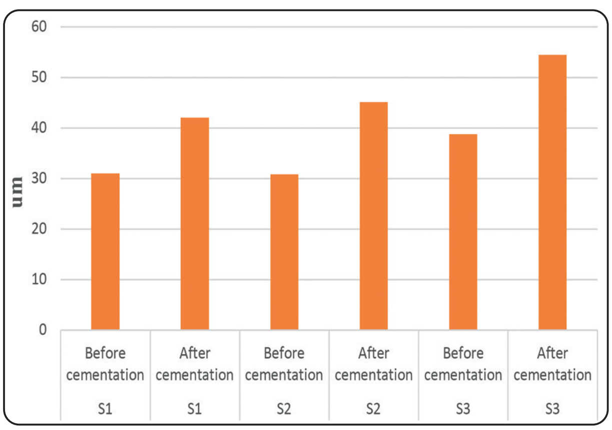
Table (2): Intergroup comparison (group II) of marginal gap values for different preparation designs:

				Design			P-value
				S1	S2	S3	
				N=6	N=6	N=6	
Marginal gap	IPS e.max Press	Before cementation	*Range*	(25.7-36.6)[a]	(27-37.11)[b]	(32.7-48.1)[a]	*0.006**
			Mean ± SD	31±3.4	30.8±3.7	38.8±5	
		After cementation	*Range*	(37.4-45.8)[a]	(41.7-50.5)[b]	(47.4-64.3)[a]	*<0.001**
			Mean ± SD	42±2.7	45.1±3.1	54.5±5.6	

One Way ANOVA test for comparison of quantitative data between the three groups followed by post hoc LSD analysis between each two groups.

Superscripts with different small letters refer to significant difference between each two groups.

****: Significant level at P value < 0.05***



Graph (2) Marginal gap values of different preparation designs, before and after cementation in group II (IPS e-max Press)

DISCUSSION

The capabilities of endocrowns have been enhanced by recent progress in dental materials. Lithium disilicate (LDS) ceramics have gained significant popularity and serve as an excellent choice for various treatment options due to their outstanding aesthetic properties and favorable fracture resistance. All-ceramic restorations have become widely utilized owing to their biological compatibility, superior aesthetics, and robust mechanical characteristics.[22] This type of ceramic has been manufactured using CAD/CAM technology along with the heat pressing method, offering benefits such as improved marginal fit, enhanced flexural strength, and lower porosity.[23] Healthcare professionals can select the appropriate ceramic material and fabrication technique for each specific clinical situation to guarantee a successful and long-lasting ceramic restoration.[24]

Traditional restoration, such as fiber reinforced posts and metal dowels, have unique limitations. Removing excessive dental structure from root canal walls may weaken the tooth.[19] Uneven stress distribution may result from variations in the elasticity modulus of dental materials compared to natural tooth structure, leading to infiltration at different bonding surfaces.[17,25]

Endocrown became a common option for conservatively restoring teeth after extensive endodontic therapy, this monolithic restoration is cemented in the pulp chamber when the root canal emerges, rather than extending into it. Endocrowns offer time-saving benefits, such as reducing the need for dental tissue extraction and more clinical and laboratory procedures. When endocrowns are cemented, they distribute occlusal stresses similarly to natural teeth due to their design and interaction with adjacent dental structures.[26-27]

Significant advancements in all ceramic restorations' microstructure have been achieved, resulting in marginal gaps that are comparable to those found in metal ceramics. The IPS e.max press and IPS e.max CAD have been developed to enhance mechanical strength and improve marginal fit while also offering outstanding aesthetics. The success of endocrowns is determined by both the material utilized and the restorative design. Marginal accuracy and fracture resistance are greatly affected by the depth extension of the endocrown in the pulp chamber.[28]

Assessing the vertical marginal gap distance is crucial for determining the long-term performance of ceramic restorations. Proper marginal fit prevents cement disintegration, plaque formation, cavities, pulpal affection, and increased stress concentration, which can lead to repair fractures later.[12]

This study compared the marginal adaptation of anterior endocrowns with different preparation depths (2mm – 5mm) and post retained crowns fabricated either by IPS e.max CAD or press.

Regarding method of construction effect on marginal adaptation;

By the findings of the current investigation, restorations fabricated by CAD/CAM technique showed a significantly higher marginal gap values than others fabricated by Pressing technique.

The literature suggests that the acceptance threshold for marginal mismatch in lithium-disilicate-based ceramics is up to 120 mm[29-30] which is higher than the measurements observed in this study.

Based on this assumption, both techniques would produce adequate crowns for clinical use. However, it is important to minimize marginal misfit to reduce the risk of biological complications and increase the longevity of restorations in clinical settings.[31]

Milling pressure and material resistance may have caused marginal fractures in brittle materials like ceramics. **Zimmermann et al.** found that the glass matrix is fragile, and ceramic crystallites can be easily fractured by milling pressure. In contrast, the pressing technique improves material compressibility and flowability.[32]

Our findings are consistent with those of ***Gold et al***.[33], who discovered that crystallization fire in CAD/CAM milled lithium disilicate-based crowns leads in increased marginal space and mismatch. Also, study by ***El Aily I. and El Dessouky S.***[34] who stated that e.max press exhibited lower vertical marginal gap in than Emax CAD in both SEM & CBCT measurements. They explained that the heat pressing process differs from CAD/CAM in that it consolidates steps and matches investment thermal expansion with ceramic material. However, faults in preparatory design are easier to address in laboratory procedures.[35]

However**,** the results of the current study were in conflict with this of ***Mostafa et al.***[36] who found that digital workflow for crown fabrication resulted in 100% acceptable crowns, while traditional methods using polyvinyl siloxane, imprint trays, and pressing techniques produced 20% unsuitable crowns. This might be different from the results of our study due to the difference in impression-taking method, as the mentioned study used the traditional impression with polyvinyl siloxane material.

Another study by ***Abduljawad DE and Rayyan MR*** [37] was in disagreement with the current study results, as they found that digitally produced endocrowns had better marginal fit compared to conventionally constructed endocrowns. They clarified that the greater marginal gaps seen in endocrowns manufactured using conventional techniques could be attributable to dimensional variances generated by the die stone, investment material, wax pattern, and die spacer. These variances, together with the human factor, are predicted to result in a greater margin of mistakes and inaccuracies. Different study designs, impression technique for heat-pressed group, wax patterns fabrication technique and teeth used in the current study lead to inconsistent and conflicting outcomes.

The MA values of the IPS e.max Press and IPS e.max CAD, however, were seen to vary between investigations, which may be related to variations in impression technique and processing methods.

Regarding effect of various preparation designs on marginal adaptation:

According to the findings of this study, endocrowns with either short or long extensions showed higher marginal gap values than crowns retained by post and core. While the long endocrown with 5 mm intra-pulpal depth showed the highest marginal gap values.

Endocrowns and crowns require distinct preparation methods. A crown die is a projected object with parallel walls, whereas an endocrown has a cavity with varying scan accuracy based on its depth. Another factor to consider is the scanner's access direction, as digital impressions can be imperfect on the distal side at certain angles.[38]

A study by ***Rocca GT et al***.[39] showed that endocrowns either with short (2 mm) or long (5 mm) depth and crowns supported by post and core, had similar marginal gap values. This is also agreed with a study by ***Ramirez et al.***[40] who found similar patterns when comparing LDS crowns on central maxillary incisor roots with medium glass-fiber posts (5 mm) to endocrowns with 5 mm endo-cores under identical laboratory testing settings. On the contrary another study reported a clinically acceptable marginal gap, but they discovered that neither the restoration type (endocrown and crown) nor the material used had a significant effect on the marginal gap. This study's findings may differ due to the use of non-cemented models and samples that were not aged.[38]

Regarding the effect of endocrown extension depth, other previous investigations by ***Shin Y.. et al.***[41] and ***Gaintantzopoulou MD and El-Damanhoury HM***[42] were in concurrence with the results of our study, as they proved that marginal adaptation is adversely impacted by increasing the intra-pulpal cavity depth extension, as they found that deeper endocrown preparation led to a larger vertical marginal gap. They explained that it would be due to locations away from the scanner were less accurate and undercuts were difficult to detect, potentially interfering with restoration settings.

Another clarification stated that increased axial length can cause friction between the fitting surface of the restoration and the cemented surface of the abutment, leading to increased marginal discrepancy with cavity depth.[43]

As mentioned before, ***Roccaa GT et al.***[39] found that there was no statistical difference in percentages of closed margins found between endocrowns with either 2 mm or 4 mm extension depth. Although the marginal gap values was higher in long endocrowns with 4mm depth than short endocrowns with 2mm depth, which may be due to fabrication of endocrowns with deep cavities in the root may have bigger margins and internal discrepancies than those with small endo-cores due to optical impression constraints.[41] Also the large cement layer thickness at the contact may lead to increased deterioration under stress.[44]

The development of stronger ceramics and adhesive techniques makes it easier to create endocrowns, which can be used as an alternative to traditional tooth repair. Nevertheless, the application of these restorations to the anterior teeth remains a topic of debate.

The current study's limitations include the fact that it was conducted in vitro, therefore oral conditions could not be accurately reflected. Only 5000 cycles were used in this study, and extra load cycles may have an impact on the results. Furthermore, thermal cyclic loading alone does not fully reflect the oral environmental conditions. These constraints may be addressed in future research to determine the effect of thermomechanical loading on endocrowns. Furthermore, long-term in-vivo studies could be conducted to evaluate the clinical performance of endocrown restorations fabricated from various CAD/CAM materials with varying preparation designs and extension depths.

CONCLUSION

With the restrictions of the current study, it was accomplished that:

- All specimens showed clinically accepted MA results. With endocrowns with 5mm depth exhibited the highest marginal gap value, while crowns retained by post and core exhibited the lowest marginal gap values
- Restorations fabricated by heat-pressing technique revealed higher MA values than restorations fabricated by CAD/CAM technique.
- Increasing intra-pulpal cavity depths increases vertical marginal gap of endocrowns made of IPS e.max CAD or Press.

CLINICAL SIGNIFICANCE

For the restoration of endodontically treated maxillary central incisors, clinicians may find that IPS e.max CAD anterior endocrowns with short depth extension (2mm) offer a more practical treatment option than standard crowns supported by post and core. Because it necessitates less clinical and laboratory procedures as well as less tooth structure removal.

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