Clinical Assessment of Recurrent Caries, Retention and Patient Satisfaction of Endocrowns versus Post Retained Crowns Using Reinforced Lithium Silicate. (A Randomized Clinical Trial)

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ABSTRACT

Objective: The purpose of this study was to clinically evaluate the effect of restoration type (endocrown versus post-retained crown) made of zirconia reinforced lithium silicate (Celtra Press) on recurrent caries, retention and patient satisfaction.

Methodology: A total of 34 patients requiring restoration of endodontically treated lower first molars. Patients were randomly assigned into two groups (n=17) according to the type of restoration used. The Control Group (PCr): received reinforced lithium silicate ceramic crowns retained with glass fiber posts. Whereas, the Intervention Group (Ec): received reinforced lithium silicate ceramic endocrowns. Heat pressing technique was used for the fabrication of both

restorations. After final cementation, the recurrent caries and retention were evaluated according to the modified USPHS criteria after three, six, and twelve months follow up intervals. Patient's satisfaction was assessed using a questionnaire after one year.

Results: There was no statistical significant difference ($P > 0.05$) between both tested groups at all intervals for all tested outcomes (recurrent caries, retention and patients satisfaction). Both groups showed no recurrent caries, and high patient satisfaction. However, only 2 restorations of each group lost their retention.

Conclusions: High clinical performance and patient satisfaction were achieved with Celtra Press regardless of the type of restoration tested. Endocrowns proved to be a reliable alternative to post-retained restorations with comparable resistance to recurrent caries, high retention and superior patient's satisfaction.

KEYWORDS

Recurrent caries; Retention; Satisfaction; Endocrown; Endodontically treated teeth; Fiber Post; Celtra Press.

INTRODUCTION

Restoring endodontically treated teeth suffering from coronal destruction still represents a clinical challenge. Loss of valuable tooth structure in such situations might dictate using full coverage restorations [1]. In cases suffering from substantial coronal loss, an extra retentive feature, such as an intraradicular post, is required. Over time, using the post and core supported restorations has become the standard in managing endodontically treated teeth [2, 3]. Various post and core systems have been used, aiming at achieving the best treatment. These comprised custom made posts and prefabricated posts [4].

Although using a post can enhance the coronal restorations retention , the post space preparation require additional removal of sound tooth structure, which would further weaken the tooth, increasing the risk of catastrophic root fracture during post cementation or function. The technique itself is considered time consuming as it involved multiple steps. In addition, inappropriate post space preparation, showed high incidence of root perforation [5]. Furthermore, post use is limited in teeth with short, narrow, dilacerated, obliterated or fragile roots [6]. Last but not least, using post- retained restorations are limited in teeth with narrow interocclusal space, in

which it is impossible to achieve adequate extra-coronal restoration thickness [6].

Recent advancements in adhesive dentistry combined with the introduction of new ceramic materials allowed the use of more conservative alternatives to post-retained crown restorations. One of these approaches was endocrowns. Endocrown s another form of adhesive indirect restorations that incorporates the intra-coronal core and the cuspal coverage as one unit, that is adhesively bonded to the tooth structure [7, 8].

Endocrowns have several advantages over post and core systems, as they are less invasive, easier to prepare, requires lesser chair time. They also do not require intraradicular preparation; hence enhance teeth preservation [5, 9]. Another important benefit of endocrowns is the reduced number of adhesive interfaces, which enhanced stress distribution and restoration retention and makes the teeth less likely to fracture [5].

Success of endocrowns depends on many factors involving the appropriate case selection, preparation design, restorative material and cement type [10]. Lithium disilicate glass ceramics were considered the material of choice for constructing endocrowns. They offered excellent mechanical properties including high flexural strength (360 MPa to 440 MPa), high fracture toughness (2-3 MPa), high esthetic appearance and superior bonding ability [11, 12]. However, modifications were made to further enhance their properties.

High-strength zirconia-reinforced lithium silicate glass ceramic material such as Celtra Press, was introduced to provide superior mechanical properties by incorporating 10% of zirconium oxide within its microstructure, while enhancing esthetics through reducing their crystal size [13, 14]. Being heat pressed allowed such material to benefit the advantages of ease of construction, accurate marginal adaptation, high mechanical properties, low porosity and less brittleness compared to conventionally fabricated glass ceramics [15]. However, limited data is available regarding the clinical performance of such material.

Restorations success can be associated to many factors, one of which is restoration retention and lack of recurrent caries. Recurrent caries is known to cause teeth weakening, which might subsequently lead to tooth loss [16, 17]. Debonding or loss of restoration retention requires restoration recementation or replacement, thus the prognosis of fixed restoration is directly related to its retention [18]. Several techniques are available to access these terms. Modified USPHS

criteria is considered one of the reliable evaluation methods, as it enabled multiple parameters assessment and provided reliable information regarding the clinical success of the tested restorations [19, 20]. Patients' satisfaction is also one of the important elements in assessing the quality of dental care [21, 22]. It is considered effective indicator for measuring the restoration success and judge service efficiency [23].

There are limited evidence-based information addressing the clinical performance of zirconia reinforced lithium silicate material (Celtra Press) restorations when used as crowns and endocrowns, especially when addressing (recurrent caries, retention and patient's satisfaction). Thus, the aim of the present study was to clinically evaluate the effect of restoration type (endocrown versus post retained crown) made of zirconia reinforced lithium silicate (Celtra Press) on recurrent caries, retention and patient satisfaction at different follow up intervals (three months, six months and one year) when restoring endodontically treated lower first molar.

The first null hypothesis of the present study was that there would be no statistically significant differences between endocrowns and fiber post-retained crowns made of reinforced lithium silicate material (Celtra Press) regarding the clinical performance (recurrent caries, retention) and patient satisfaction. While, the second null hypothesis was that there would be no statistically significant difference in the evaluated outcomes (recurrent caries, retention and patient's satisfaction) within each group, across follow up periods.

MATERIAL AND METHODS

Ethical considerations and approval

This study and the template informed consent form were approved by the Ethics Committee of Scientific Research – Faculty of dentistry- Cairo University- in October- 2018.

Registration

This trial was registered at the Clinical Trials.gov registry under registration number NCT03713918 on October 18, 2018.

Study Design

The current study was a randomized clinical trial (RCT), in which the recruited patients were allocated randomly to two groups. In the first group, the control Group (PCr): patients received

reinforced lithium silicate ceramic crowns retained with glass fiber post restoring endodontically treated lower first molars. Whereas, in the second group, the Intervention Group (Ec): patients received reinforced lithium silicate ceramic endocrowns restoring endodontically treated lower first molars.

Sample size calculation:

The sample size for this study was determined based on data obtained from a previous study [24] and calculated using a statistical software (G-power program, Version 3.1.2, Vanderbilt University, Nashville, Tennessee, USA), employing a power of 80% and a 5% alpha level of significance. Sample size calculation was performed using Chi-square test.

Participant's selection:

A total of 34 patients (10 males and 24 females) with age range between 18-55 years old were selected for this study. Their chief complaint was to restore their posterior endodontically treated teeth back to normal and to prevent further damage.

The inclusion criteria included patients with endodontically treated permanent lower first molar indicated for fixed restoration, showing adequate remaining sound tooth structure (1.5-2mm width and height above cemento-enamel junction), adequate root canal filling, absence of any periapical pathosis or fistula or pockets or abnormal tooth mobility or history of sensitivity to pressure. Inclusion criteria also included patients with low caries index, group function occlusion, healthy gingiva and normal sulcus depth. In addition, teeth with pulp chamber depth not less than 3 mm were only included.

Patients with endodontically treated permanent lower first molar suffering from root fractures, or suffering from xerostomia, severe periodontal affection with more than 1/2 bone height loss, parafunctional habits as bruxism, poor oral hygiene, lack of opposing occluding dentition in the area intended for restoration were excluded from the present study.

Randomization, allocation concealment, and implementation

A randomized sequence was generated using computer software (random.org) to allow participants in this trial to be allocated to the tested groups, to ensure the unpredictability of

allocation sequence generated. Each generated random sequence represented the number of the patient with letter A (comparator) of B (intervention) in random manner. The participants were allocated to the two test groups with 1:1 allocation ratio. Sequentially numbered opaque sealed envelopes containing the grouping generated previously from inside and nothing from outside were used for allocation concealment. The envelopes were released to the operator at the time of tooth preparation. Sample grouping is shown in Table (1).

Control group (PCr Group)	**Intervention group (Ec Group)**	**Total number of restorations**
Celtra press reinforced lithium silicate crowns retained with glass fiber posts	Celtra press reinforced lithium silicate ceramic endocrowns	(n=34)
(n=17)	(n=17)	

Blinding

The participants and the statistician were blinded to the restoration used, while the operator and the assessors were not blinded due to the difference in the tested restoration preparation protocols and designs.

Prosthetic steps:

Infection control: Standard precautions for infection control were followed for all patients in each step. These included proper risk assessment, sterilization and employing protective equipment to prevent the spread of infection between the patients and protect the healthcare providers.

Diagnostic phase: In this phase, proper extra-oral and intra-oral examination together with pre-operative photographs, radiographs and diagnostic casts were used to assess the patients and data were recorded in a comprehensive diagnostic chart. Patients deviating from the inclusion criteria specified were excluded from the study. Profound teeth scaling, polishing, shade selection were done after finalizing diagnosis and prior to teeth preparation.

Tooth preparation phase: In Group (PCr), where post-retained restorations were fabricated, post space was prepared leaving 3-5mm apical seal. This was achieved using Gates Glidden burs (NORDIN swiss dental products) size 2 and 3 for gutta percha removal, and post drills presented in the fiber reinforced post kit (Elsodent post, Elsodent dental products, France). The post was

then cemented using self-adhesive resin cement (Bisco BisCem, Bisco, USA) following the manufacturer's instructions and Build-It TM FR core material (Pentron Clinical Technologies LLC, Wallingford, USA) was used for building up the core [25,26].

To receive full coverage Celtra press crown restoration, tooth preparation was performed following the manufacturer's instructions to ensure optimum structural durability. The occlusal preparation aimed at achieving 1.5-2 mm clearance, while following the occlusal anatomy with a 45-degrees functional cusp bevel placed at the functional cusps. Axial preparation was started by freeing the contact with fine tapered stone then was completed by round end tapered diamond stone to achieve 1.5 mm axial reduction with 1mm thick supra-gingival or equi-gingival deep chamfer finish line [27]. Finishing the preparation was achieved by rounding any sharp line or point angle using finishing stone to eliminate any future stress concentration within the intended restoration. All preparations were accomplished by a single operator to ensure standardization and a silicone index was used to check the amount of occlusal and axial reduction.

In Group (Ec), where endocrowns were fabricated, the conventional 90-degrees circumferential butt margin design was employed. A 2 mm flat occlusal reduction was performed using a wheel diamond stone to allow for sufficient clearance providing optimum structural durability of the restoration [27,28,29]. All margins were kept supra-gingival or equi-gingival with at least 1 mm axial wall thickness to ensure sufficient strength of the remaining tooth structure [11,30]. A central retentive cavity with at least 3±0.5 mm depth extending into the pulp chamber space was also prepared. The central cavity was prepared to have slight occlusal divergence (8-10 degrees) that was standardized using a round end cylindrical-conical diamond stone orientated along the long axis of the tooth. A thin layer of flowable composite (3M Filtek Z350XT flowable composite, USA) was applied at the depth of the central cavity to obtain a smooth flat pulpal floor [11, 28].

Impression making phase: Double mix-two steps secondary impression was made for all preparations in both groups using elite HD+ addition silicone impression material (Elite HD+, Zhermack, Italy) to provide an accurate impression of the prepared tooth [31,32]. Defect-free impressions that accurately reproduced the preparation performed were disinfected and sent to the dental laboratory.

Provisionalization phase: A CharmTemp (DENTKIST, Inc.Korea) temporary material was used to construct direct provisional restoration in both groups, aided by the sectional impression that was previously made. All temporary restorations were finished, polished and cemented using eugenol-free temporary cement (RelyX Temp NE, 3MESPE, USA).

Try-in phase: A PMMA (PMMA blanks, China) crown and endocrown were constructed using CAI/CAD/CAM technology utilizing extra-oral scanning of the master cast using Smart optics scanner (Sensortechnik GmbH, Germany), CAD designing using EXOCAD software (ExoCad GmbH, Germany) and 5-axis milling of the restoration using Ronald MC X5 milling machine (Roland DGA, California). The PMMA restorations were used to check the marginal fit, shape, contour, proximal contacts and the overall integration of the designed restoration intra-orally. Occlusal interferences were also checked in both centric and eccentric movements with the help of articulating paper. Any minor interferences or modifications were reported and adjusted to allow for appropriate final restoration construction; however, major modifications dictated repeating the scanning and the designing phases.

Restoration construction phase: Final crown and endocrown restorations in both groups were fabricated from Celtra press ingots (Sirona Dentsply, USA) using the heat pressing technique. Wax pattern (Aidite wax blank, China) was milled based on the design previously employed for the fabrication of PMMA crowns with the cement thickness set to 50 micro-meters using Ronald MC X5 milling machine. Each milled wax restoration was sprued and invested using a Celtra Press investment material (Sirona Dentsply, Germany) according to the manufacturer's instructions. After wax elimination, the correct size and shade of the Celtra Press ingot was selected and placed into the pressing hole and the investment ring was placed in the center of the firing platform of the heat pressing furnace (Programat EP 3010, Ivoclar Vivadent AG, Schaan/Liechtenstein). The pressing program was set and preceded according to the manufacturer's instructions. After pressing completion, rough and fine divestments were done followed by finishing and polishing using finishing diamond and rubber polishers. Staining, surface characterization and glazing were performed to provide optimum esthetic outcome. Stain and glaze firing were performed after application of even layer of desired stains for characterization directly onto the unfired glaze layer using a fine brush. The firing cycle was carried out according to the specifications dictated by the manufacturer.

Restorations cementation phase: The fitting surface of each pressed restoration was etched using 9.5% hydrofluoric acid gel (Porcelain Etch, BISCO, USA) for 20 seconds then rinsed for 60 seconds with running water and dried for 30 seconds with moisture-free air to provide a chalky white appearance. The etched surface was then conditioned using a silane coupling agent (Porcelain Primer, BISCO, USA) and allowed to dry for 60 seconds [11,26]. Cementation was then proceeded using dual cure BisCem resin cement (BISCO, USA) following the manufacturer's instructions. After cementation completion, final checking was performed to assess the presence of any high spots or occlusal interferences in the centric and eccentric movements using an articulating paper. Minor adjustments were carried out intraorally using finishing and polishing instruments.

Postoperative instruction phase: Strict oral hygiene measures were instructed to the patient to ensure restoration survival.

Outcomes assessment: The present study had a one-year follow-up period for both groups as shown in Table (2). Recurrent caries (assessed directly intraorally aided by a sharp explorer) [33,34] and retention (assessed visually intraorally) were assessed based on modified USPHS criteria at three different intervals (3, 6 and 12 months). Whereas, patients satisfaction was assessed using a questionnaire after one year post-cementation. The questionnaire assessed the personal opinion of each patient regarding esthetics, function, pain, retention and gingival response. The answers to the questions were "Yes" or "No" to aid in simplicity.

Table (2): The outcomes tested in the present study.

	Outcome Name	**Device**	**Measuring unit**
Primary (1ry) outcome	Recurrent caries	(USPHS) criteria	**Alpha (A) score:** No apparent caries contiguous with the restoration margin **Bravo (B) score:** Observable caries contiguous with the restoration margin
Secondary (2ry) outcome	Retention	(USPHS) criteria	**Bravo (B) score:** Restorations that are present and fully retained. **Bravo (B) score:** Restorations that are partially retained with some portion of the restoration still intact **Bravo (B) score:** Restorations that are completely

			missing
	Patient satisfacti on	Questionnaire	Yes/No

Statistical analysis

Statistical analysis was performed with SPSS 20 (Statistical Package for Social Science, IBM, USA) Graph Pad Prism (Graph Pad Technologies, USA) and Microsoft Excel 2016 (Microsoft Co-operation, USA). At the follow up recall visits, eight patients dropped out of the study. The data collected from the remaining participants were recorded and statistically analyzed. Comparison between the tested groups and the results at different follow up intervals was performed using Chi square test.

RESULTS

1. Recurrent caries

Comparison between Group PCr and Group Ec revealed insignificant difference ($P > 0.05$) between them at all intervals with absence of recurrent caries as presented in **Table (3)** and **Figure (1).**

Table (3): Results of the comparison between the effect of restoration type (PCr versus Ec) made of Celtra press on recurrent caries after the follow up intervals (frequency and percentages of Alpha (A) and Bravo (B) scores:

Recurrent caries		Alpha (A) score		Bravo (B) score	
		N	%	N	%
1st follow-up after 3 months	PCr Group	13	100.0%	0	0%
	Ec Group	13	100.0%	0	0%
	P-value	1.00		----------	
2nd follow-up after 6 months	PCr Group	13	100.0%	0	0%
	Ec Group	13	100.0%	0	0%
	P-value	1.00		----------	
3rd follow-up after 12 months	PCr Group	13	100.0%	0	0%
	Ec Group	13	100.0%	0	0%
	P-value	1.00		----------	

N: count %: percentage P: probability level which is significant at $P \leq 0.05$

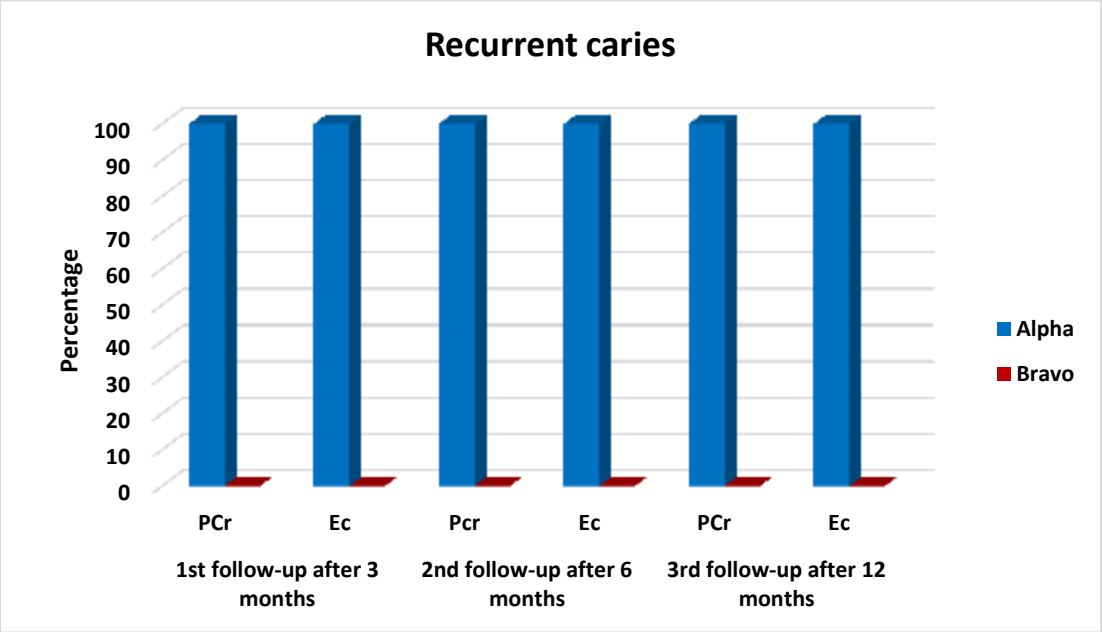

Figure (5): Bar chart showing the comparison between the effect of restoration type (PCr versus Ec) made of Celtra press on recurrent caries after the follow up intervals (frequency and percentages of Alpha (A) and Bravo (B) scores

2. Retention

Comparison between Group PCr and Group Ec regarding retention revealed insignificant difference (P > 0.05) between them at all intervals as presented in **Table (4)** and **Figure (2).**

Table (4): Results of the comparison between the effect of restoration type (PCr versus Ec) made of Celtra press on retention after the follow up intervals (frequency and percentages of Alpha (A), Bravo (B) and Charlie (C) scores):

Retention		Alpha (A) score		Bravo (B) score		Charlie (C) score	
		N	%	N	%	N	%
1st follow-up after 3 months	PCr Group	13	100.0%	0	0%	0	0%
	Ec Group	13	100.0%	0	0%	0	0%
	P-value	1.00		----------		----------	
2nd follow-up after 6 months	PCr Group	12	92.3%	0	0%	1	7.7%
	Ec Group	12	92.3%	0	0%	1	7.7%
	P-value	1.00		----------		1.00	
3rd follow-up after 12 months	PCr Group	11	84.6%	0	0%	2	15.4%
	Ec Group	11	84.6%	0	0%	2	15.4%
	P-value	1.000		----------		1.000	

N: count %: percentage P: probability level which is significant at P ≤ 0.05

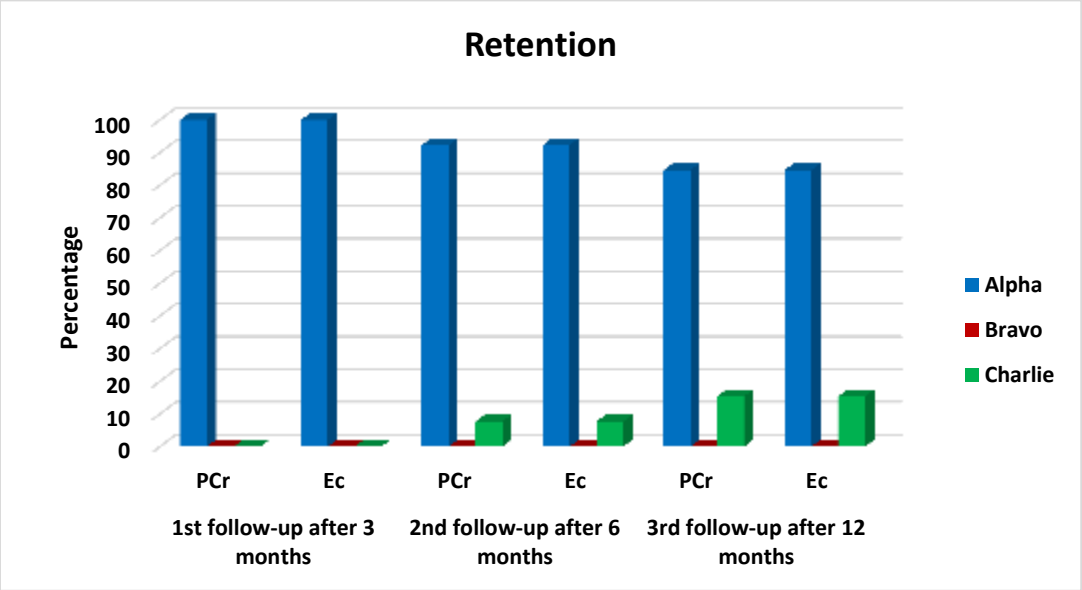

Figure (6): Bar chart showing the comparison between the effect of restoration type (PCr versus Ec) made of Celtra press on retention after the follow up intervals (frequency and percentages of Alpha (A), Bravo (B) and Charlie scores

3. Patient satisfaction

Comparison between Group PCr and Group Ec regarding patients satisfaction revealed insignificant difference (P > 0.05) between them as presented in **Table (5)** and **Figure (3)**

Table (5): Results of the comparison between the effect of restoration type (PCr versus Ec) made of Celtra press on patient`s satisfaction after one year follow up (frequency and percentages of (No) and (Yes) answers:

Patient satisfaction			No		Yes	
			N	%	N	%
Q1	Are you satisfied with your Endocrown/Crown appearance?	PCr Group	0	0 %	13	100 %
		Ec Group	0	0 %	13	100 %
		P-value	---------		1.000	
Q2	Are you satisfied with your Endocrown/Crown color?	PCr Group	0	0 %	13	100 %
		Ec Group	0	0 %	13	100 %
		P-value	---------		1.000	
Q3	Have you noticed any color change in your crown till now?	PCr Group	13	100 %	0	0 %
		Ec Group	13	100 %	0	0 %
		P-value	1.000		---------	
Q4	Do you feel that your crown looks natural?	PCr Group	0	0 %	13	100 %
		Ec Group	0	0 %	13	100 %
		P-value	---------		1.000	

Q5	Have you suffered from any kind of pain or problem during endocrown use?	PCr Group	13	100 %	0	0 %
		Ec Group	13	100 %	0	0 %
		P-value	1.000		---------	
Q6	Do you like your crown alignment?	PCr Group	0	0 %	13	100 %
		Ec Group	0	0 %	13	100 %
		P-value	---------		1.000	
Q7	Do you feel that the crown is in harmony with the adjacent teeth?	PCr Group	1	7.7 %	12	92.3 %
		Ec Group	0	0 %	13	100 %
		P-value	0.32		0.35	
Q8	Have you experienced gingival or periodontal inflammation around Endocrown / crown after its insertion?	PCr Group	13	100 %	0	0 %
		Ec Group	13	100 %	0	0 %
		P-value	1.000		---------	
Q9	Is there any kind of chipping/fracture/crack that happened to the restoration through the year after restoration?	PCr Group	13	100 %	0	0 %
		Ec Group	13	100 %	0	0 %
		P-value	1.000		---------	
Q10	Has the crown stability affected through this year?	PCr Group	11	84.6 %	2	15.4 %
		Ec Group	11	84.6 %	2	15.4 %
		P-value	1.000		1.000	

N: count %: percentage P: probability level which is significant at $P \leq 0.05$

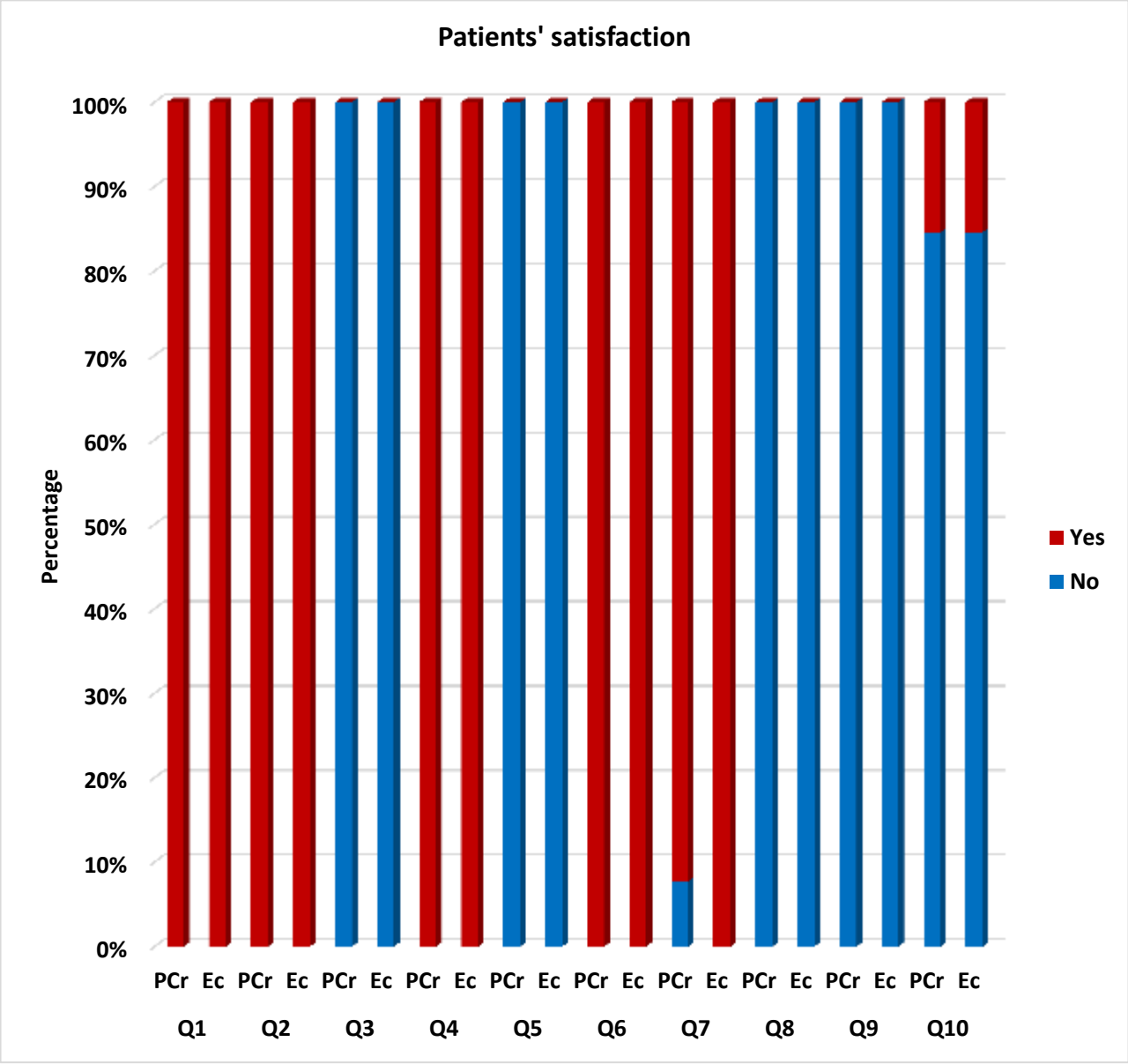

Figure (7): Ec) made of Celtra press on patient`s satisfaction after one year follow Bar chart showing the comparison between the effect of restoration type (PCr versus up (No and Yes answers).

DISCUSSION

Minimally invasive preparations and maximal dental tissue conservation have become the gold standards for endodontically treated teeth restoration. These concepts reduced further weakening of such teeth and enhanced their longevity [35]. The introduction of advanced ceramic materials offered intended to enhance the success and longevity of conservative restorations such as

endocrowns. Testing the performance of endocrowns in comparison to conventional post-retained restorations have become strongly recommended to assess their long-term success.

Regarding the results of recurrent caries, our results failed to reject the first and second null hypotheses, where there was no significant difference between both groups through all follow up periods. All teeth restored with endocrowns and crowns were free from caries. This might be attributed to good marginal adaptation stablished by the fabrication technique employed, which depended on combining pressing technology and CAD/CAM designing of the wax pattern, which provided the restorations with more accurate marginal and internal adaptation and higher mechanical properties than that of conventional pressing technique [12,15,36]. Appropriate marginal adaptation and minimal marginal gap enhanced the restoration fit, prevented the dissolution of the luting cement with a subsequent leakage possibility, which might cause recurrent caries and consequently loss of retention [15,37].

Lack of recurrent caries might also be due to proper patient selection with low caries index, complete removal of caries before tooth preparation phase leaving no any residual caries, supra-gingival finish line position, and patients' compliance with post-operative instructions of good oral hygiene measures [38,39].

Another reason that might have contributed to lack of recurrent caries was using adhesive resin cement in both groups making use of their ability to minimize the marginal discrepancies. In addition, they were able to absorb stresses during load application, which enhanced the restoration's fracture resistance [25,40,41]. Being dual cured, the cement used ensured complete polymerization especially at the deep preparations by combining both light and chemical activation which improved the degree of conversion in deeply seated areas and allowed adequate working time [42].

In addition, setting the cement space to 50 microns in all restorations as recommended allowed proper restoration seating with appropriate marginal adaptation, reducing the risk of recurrent caries; where cement space less than 40 microns was found to inhibit the crown seating, increasing the marginal discrepancy [43,44].

Our results came in agreement with other studies, who found no recurrent caries relevant to CAD/CAM or pressed lithium disilicate endocrowns and crowns after 12, 24 and 28 months

[30,45].

Regarding the results of retention, our results also failed to reject the first and second null hypothesis, as both groups revealed insignificant difference at all intervals, with only two restorations from each group showing loss of retention (debonded). Debonded restorations were found to be intact with no fractures seen in the restoration or the tooth structure, and they were rebounded with no need for new replacement

High restorations retention might be attributed to the presence of glassy phase in the microstructure of the restorative material used (celtra-press), which permited the restorations to be efficiently etched and adhesively bonded to the tooth structure, enhancing the restoration retention [14,46]. Furthermore, the large molar surface area available for restoration bonding, provided by molar teeth, promoted effective adhesion and allowed adequate dissipation of the occlusal forces over the entire fitting restoration surface, tooth and supporting structure, reducing stress concentration in the cement layer, hence enhancing restoration retention.

High retention might also be contributed to performing standardized preparations with a minimum occlusal convergence (in Pcr group) and minimum divergence (in Ec group) together with using adhesive resin cement [47,48]. The employed restorations fabrication technique might also have improved the retention of tested restorations, as it allowed high marginal adaptation as previously mentioned.

Both groups had comparable results regarding loss of retention, which came in agreement with which other study who showed three debonded zirconia endocrowns through 13 months [8].

Regarding the results of patient satisfaction, our results failed to reject the null hypotheses, where there was no statistical significant difference between the tested groups after one year. All patients were satisfied, except 4 patients (2 in each group) who were not satisfied due to loss of restoration retention, and one patient was dissatisfied due to problem of in harmony with restoration in Group Pcr.

High level of patients satisfaction might be due to the restorative material used (zirconia-reinforced lithium silicate) which offered high esthetics and adequate mechanical properties [14, 15,49].

High level of patient's satisfaction might also be due to the meticulous adherence to the inclusion criteria set in the present study, where patients suffering from any confounding factor that might affect the longevity and success of the restorations tested; such as salivary deficiency or occlusion abnormalities were excluded. It might also be contributed to appropriate shade selection and subsequent staining and characterization of the restorations, which improved the esthetic outcome of the restoration. In addition, excess cement was meticulously removed to eliminate any remnants that might adversely affect the gingival health and subsequently the patients satisfaction [50]. Furthermore, any final adjustments were followed by proper intra-oral finishing and polishing to attain smooth surface, reduce any risk of restoration fracture or chipping and prevent abrasion of the opposing natural teeth, enhancing the longevity of the restoration and subsequently contributing to patients satisfaction [8,50]**.**

Having the majority of patients in both groups showing satisfaction came in agreement with other studies who reported high patient satisfaction in terms of the shape, shade and form of the endocrowns and crown [8, 30,45].

Limitations: The limitations of this study included testing single type of ceramic material (ZLS), relatively small sample size and the short follow-up period.

CONCLUSIONS

Within the limitations of the present study, the following conclusions could be drawn:

1. High clinical performance and Patient satisfaction were achieved with Celtra Press regardless of the type of restoration tested.
2. Endocrowns proved to be a reliable alternative to post-retained restorations with comparable resistance to recurrent caries, high retention and superior patient's satisfaction.

RECOMMENDATIONS

1. Increase the follow-up period to evaluate the long-term behavior of Celtra Press crowns and endocrowns.
2. Conduct more clinical trials to evaluate other clinical criteria; such as marginal integrity, discoloration, fracture resistance of Celtra Press crowns and endocrowns
3. Conduct more clinical trials to assess the behavior of Celtra Press endocrowns in premolars

and anterior teeth.

Clinical implications:

When using Celtra Press, endocrowns with butt joint margins are considered a reliable alternative to the conventional post-retained crowns in restoring endodontically treated lower molar teeth.

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Figure legends

Figure (1): Representative pre-operative photos of each investigated group a. A case of group (1) b. A case of group (2)

Figure (2): Representative preparation photos of each investigated group a. A case of group (1) b. A case of group (2)

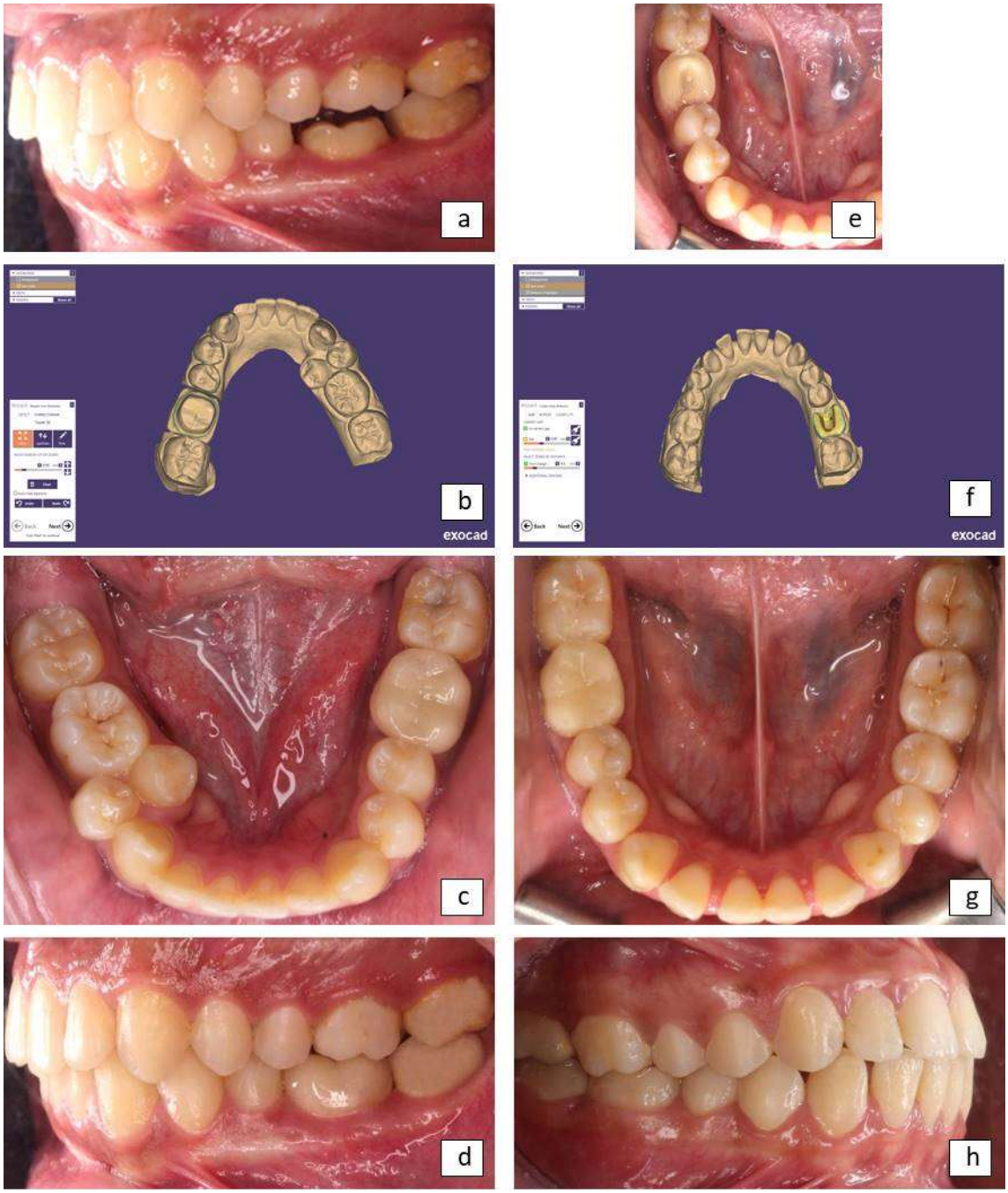
Figure (3): CAD designing of the a. crown b. endocrown “occlusal view”

Figure (4): Representative post-operative photos of each investigated group after cementation a. A case of group (1) b. A case of group (2)

Figure (5): Bar chart representing comparison of recurrent caries in both groups

Figure (6): Bar chart representing comparison of retention in both groups

Figure (7): Bar chart representing comparison of patient satisfaction in both groups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