

# Clinical Performance & Patient Satisfaction of Monolithic Zirconia (5Y), Lithium Disilicate and Modified PEEK CAD-CAM Endocrown Materials: 3-Year Clinical Prospective Study

Raafat Tamman<sup>1\*</sup>, D Samar Hatem Abuzinadah<sup>2</sup>, D Abdulrahman Jafar Alhaddad<sup>3</sup>

<sup>1</sup>Department of Fixed Prosthodontics, Faculty of Dentistry, Assiut University-Deraya University, Egypt

<sup>2</sup>Department of Restorative Dentistry, King Abdul-Aziz University, Faculty of Dentistry, Jeddah, Saudi Arabia

<sup>3</sup>Department of Oral and Maxillofacial Prosthodontics, King Abdul-Aziz University, Faculty of Dentistry, Jeddah, Saudi Arabia

## ABSTRACT

*Statement of problem:* Endocrown is a recent variety of Onlay; still, dentists have until now to find a comprehensive knowledge of the scientific outcomes of material selection of endocrowns.

*Objective:* This investigation aimed to determine clinically whether endocrowns are a reliable replacement to post-retained restorations and which materials are best adapted for fabricating endocrowns.

*Material and methods:* The endocrown evaluation clinical study is an open-label, comparable groups, blinded organized study at Assiut dental university hospitals. A sum of 40 participant will be involved in this study receiving of usual teeth endodontics management, and indicated to endocrown restorations, and will be allocated into three categories in accordance with the material kind (lithium disilicate, monolithic zirconia, and modified PEEK material). Clinical assessments by modified US Public Health Service criteria by two separate assessors. The result will be including the following criteria: Recurrent caries, Proximal contact, occlusal surface contact, Tooth integrity, and Patient satisfaction. All obtained records analysed by an independent statistician.

*Results:* After an examination interval of 3 years, success rates were 94.87 %. one restoration had to be changed due to clinically undesirable fractures and another after debonding rebonding again. The 3-year survival rate was (94.87%). there was a statistically significant differences for all variables along the 36 months follow up periods starting from 18 m to 36m. there no statically significant differences between monolithic zirconia and lithium disilicate but significantly different from modified PEEK materials for all criteria evaluated.

*Conclusions:* Bonded endocrowns protocol exhibited a promising clinical functioning around an examination time of 3 years (94.87%). Clinical relevance of translucent zirconia, lithium disilicate ceramic, and PEEK endocrowns are an appropriate restorative therapy choice for molar endocrown.

**Key words:** Clinical trials, endocrown, Monolithic zirconia, Lithium disilicate, PEEK materials, CAD-CAM

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**Corresponding author:** Raafat Tamman  
**e-mail** ✉: raafat@aun.edu.eg  
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## INTRODUCTION

Based on the deduction of the systemic review 2016, The accessible literature recommends that endocrowns might function likewise or superior to the usual therapies treating posts reinforced restorations, straightforward composite resin, or inlay/onlay restorations.

Nevertheless, warnings must be chosen when clarifying the outcomes of in vitro studies. Additional research is

required to validate that endocrowns restoration for root canal treated teeth are a viable choice [1].

Furthermore, in systemic review 2019, it has been concluded that Endocrowns are a dependable replacement to post-retained restorations for molars and appear encouraging for premolars, A specific planning proposal and a meticulous bonding procedure must be followed, and The new nanocomposite resins and lithium disilicate seem to have advantages in the fabrication of endocrowns [2].

Endocrowns are monobloc restorations that incorporate the crown and core into a single piece. Thirty, four. It

comprises all cusp with a rounded shoulder margin and stretches to the pulpal floor.

Endocrowns use the usable pulp chamber surface as a micromechanical retention while the adhesive resin cement serves as a micromechanical retention [3,4]. Endocrowns were identified as efficient restoration of endodontic molars with massive coronary structural damage [5,6].

Endocrowns are an ideal treatment option, according to the findings of both direct and indirect research. In the short, medium, and long term, molars restored in this way have had excellent survival rates. Clinical results are also satisfactory and are like those seen with crown-restored molars.

Endocrowns have had less catastrophic failures than crowns (with or without post retained restoration), with endocrowns having 6% root fractures and crowns having 29%. The majority of endocrown failures (71%) were caused by loosening [7].

Besides, advances in digital dentistry techniques in dental clinics and laboratories. On the same line, another advances on materials available for milling by CAD-CAM, these materials composed mainly full ceramics, resin-based ceramics, and ceramic-based resin.

All materials classified according to the chemical microstructures to 3 groups: (1) glass-matrix type, (2) polycrystalline types, (3) resin-based ceramics. Totally the three categories present reliable esthetic functioning, mechanical properties, and biocompatibility [8,9].

Regarding the selections of materials to produce endocrowns have been strengthened, surface treated ceramics since they deliver mechanical potency sufficient to tolerate usual occlusal load and sufficient adhere force to the tooth composition [10,11].

The optimum choice looks selected pressed or milled (CAD-CAM) ceramics strengthened with lithium disilicate [12].

Lithium disilicate exhibits high mechanical strength, exceptional bonding characters to dental components [13], and exceptional aesthetics, as the width and size of the ceramic material intended for an endocrown are superior to that of a standard ceramic crown [14].

A newfound formulation of zirconia is 5 mol% yttria-stabilized zirconia (5Y-Z), which has been advertised as "translucent" or "anterior" zirconia.

This formula of zirconia is in-between in mechanical and optical properties to 3Y-PSZ and lithium disilicate [15,16]. As this formula of zirconia is obtainable from several companies, the logical clinical proof is required to build up proposed regulations for using the of 5Y-Z as endocrowns.

In a review performed in 2015, translucent zirconia was described as the highly recommended material for posterior single crowns, and lithium-disilicate as the highly recommended material for anterior single crowns [17].

These recommendation favorites can be assigned to the promising strength of zirconia and the translucency of lithium-disilicate.

The introduction of 5Y-ZP indicates the mechanical characters of zirconia with esthetic characters like that of lithium disilicate, but these claims should be assessed directly.

Besides, A modified PEEK materials comprising 20% ceramic fillers (BioHPP; Bredent GmbH) has suitable mechanical characteristics and outstanding biocompatibility [18,19]. It can be consumed for the creation of restorations either by injection molding or CAD-CAM procedures.

The benefits of utilizing this substance are the rejection of hypersensitive responses, appropriate friction resistance, reliable polishing properties, and minimal plaque attraction [20].

The main improvement of this modified PEEK material is a 4-GPa elastic modulus, creating it as flexible as bone and permitting it to perform as a stress breaker and decrease the strengths transmitted to the restorations and the tooth root consequently [21].

This, in linking plus reliable bond characteristics to dental compositions when bonded with the adhesive bonding agent, might render the usage of PEEK a feasible option for the rebuilding of root canal treated teeth via the usage of endocrowns [22-25]. Research assessing the criteria of this substance are limited [26-29]. Presenting articles mainly experimental research.

The rationale of this prospective trial was to evaluate the clinical working of endocrown and to evaluate the clinical properties of several restorative materials.

The null hypothesis was that there would be no difference between the three restorative materials (5Y-Z, lithium disilicate, and modified PEEK material) under clinical use and patient satisfaction.

## MATERIALS AND METHODS

This is a prospective, randomized, open control trial with three parallel balanced arms. Patients will be admitted to the Department of Prosthodontics, University Dental Hospital, Faculty of Dentistry, Assiut University, Egypt, registered #AUAREC2020118-6 at 8 november 2017 by ethical committee of faculty of dentistry, Al Azhar university, Assiut. scheduled between 2016 and 2019. Registration schedule, intervention and evaluation described as described in Table 1.

**Table 1: Typical protocol items recommendations for criteria and interval periods.**

Time		Study period							
		Pretreatment	Posttreatment	6 m	12 m	18 m	24 m	30m	36 m
Admission		x							
Eligibility screen		x							
Informed consent		x							
Baseline data collection		x							
Randomized subject		x							
Allocation		x							
Type of material	Lithium disilicate ceramic	x							
	Zirconia	x							
	PEEK	x							
Modified USPHS criteria	1. Interproximal contact	x	X	x	x	x	x	x	x
	2. Occlusal surface contact								
	3. Secondary caries	x	X	x	x	x	x	x	x
	4. Tooth integrity	x	X	x	x	x	x	x	x
	5. Patient satisfaction	x	X	x	x	x	x	x	x

### Inclusion criteria

- The participant is fit and is 20–55 ages old and has Endodontically treated first molar treated teeth indicated to endocrown restoration with lack of diagnosis of a periapical lesion, fistula, swelling of periodontal tissues, atypical tooth movement, history of sensitivity to pressure, and no root breakage, as clarified by x-ray.
- The participant contains 3 or 4 sides of the integral tooth material after the whole root canal treatment.
- The participant maintains excellent oral cleanliness.
- The participant permits signaled a notified consent form.
- Participants wanting to return for follow-up inspections and evaluations and not sharing in any other clinical assessment.
- Participants are bodily and mentally up to stand usual restorative protocols.
- The participant has obtained a Class A measurement along with the modified US public health service (USPHS) criteria after insertion of the endocrown.

### Exclusion criteria

- Discernible damage of the periapical tissue or occurrence of large cysts or both.
- Patients with poor oral hygiene and Serious periodontitis.
- Oral cancer (s).
- Undertaking radiation treatment.

- Pregnancy.
- Psychological disorder or systemic disorders.
- Incompetent of self-care.
- Unacceptable for the study as reasoned by the investigators.
- Participants suffer from parafunctional habits.

### Enrolment

Patients who meet the inclusion criteria are selected from the Dental Clinics of the Department of Fixed Prosthodontics, Assiut University (Internal Recruitment). Patients are examined until the target number is reached (sequential sampling).

Sample size: 13 patients in each group can reject the null hypothesis that the case indicators are equal probability (G. power) of 0.8. This number should be increased to 14 in a group to cover possible losses during subsequent actions.

### Participants

Forty patients will be admitted according to specific enrolment criteria. Random sorting will be done using computer-generated tables. This number will be hidden using allocated vague and sealed envelopes.

Upon completion of the choice rules, the 40 adequate patients will be arbitrarily allocated into three categories in the allotted ratio of 1: 1: 1 according to endocrown material used (lithium disilicate (IPS. Emax), monolithic zirconia and PEEK material) described in Table 2.

**Table 2: Type, manufacturer, composition, and mechanical properties of 3 tested materials.**

Material	Code	manufacturer	Ceramic type	Composition	Modulus of elasticity (GPa)	Flexure strength (MPa)	Vicker hardness (MPa)
IPS e.max CAD	E	Ivoclar Vivadent AG	Lithium disilicate glass-ceramic	Glass-ceramic	95	400	6000
Zenostar T	Z	Wieland Dental + Technik GmbH & Co. KG, Pforzheim, Germany	Monolithic translucent zirconia	ZrO <sub>2</sub> + HfO <sub>2</sub> + Y <sub>2</sub> O <sub>3</sub> (.99%)	210	900	7000
				Y <sub>2</sub> O <sub>3</sub> (>4.5 - .6.0%), HfO <sub>2</sub> (.5%)			
				Al <sub>2</sub> O <sub>3</sub> + other oxides (.1%)			
Modified PEEK material	B	BioHPP; Bredent GmbH)	Resin ceramic	20% ceramic Fillers in the resin matrix	4	350	2300

Three dentists will contribute to this trial and all of them will have undergone regulated endocrown restoration exercises before the start of the study. Number of participants allocated to every dentist is unidentified and differs due to factors beyond the control of the study. These three dentists will not be involved in any other procedures related to this clinical trial or data collection.

### Preparation groups

The trial will be conducted on outpatient at Fixed Prosthodontics Clinic, Faculty of Dentistry, Assiut University. Followers will meet in the presence of patients on the initial visit. The procedures appointments will be designed as follows.

First visit: Clinic secretary invites participants for preoperative documents before the tooth preparation process, facial adhesion reminder session, intra & extra-oral clinical examination, radiographic examination, pre-operative photography, performance cast analysis, and waxing up process. Each participant is asked to sign a written consent letter in the Arabic patient's native language

Second visit: To prepare the teeth for the three groups for which an endocrowns restoration is planned, follow these steps: (1) All deteriorated or broken parts of the tooth are eliminated and an anatomical occlusal cutback of 2 mm is achieved. reached to shape a smoothed 90-degree shoulder rim. (2) The gutta-percha is peeled to a extent of not more than 2 mm and sealed with composite resin. (3) The undercuts of the dental cavity are blocked with a nano-hybrid composite resin, which serves as the base material. A 2 to 5-degree divergence of the vertical walls is made with a conical flat end tapered diamond drill. (4) Finish the cavity with the same rotary instrument that was used during preparation at a low rotation speed. Round off all interior walls to enable impression recordings and restoration siting and removal as following guidelines advocated<sup>30</sup>. then secondary impressions and temporization.

Make maxillary and mandibular polyvinyl siloxane impressions ((Elite HD; Zhermack-GmbH), and the

working cast was poured with Type IV dental stone (Prima-rock; Whip Mix Corp), which are then digitized. The anatomical outline determined following the catalog of the lab CAD-CAM system (Ceramill Motion 2; Amann Girrbach AG). Introduce the different material blocks into the milling machine and grind the restoration, then the maturation of materials completed in a special furnace according to the manufacturer's instructions.

Related to the endocrown core was constructed of PEEK using conventional wax lost technology, use up a vacuum press device (2 presses; Bredent GmbH) developed for this material. The core was assessed clinically, and the fit was checked. The core of PEEK was covered with a composite polymer primer (Visio.link; Bredent GmbH) and an indirect light-curing composite polymer facing material utilized in layers.

The restoration was accustomed intraorally and refined. The endocrown was sandblasted with 110 mm aluminum oxide and was finally bonded with dual-polymerizing resin cement (Variolink Esthetic DC; Ivoclar Vivadent AG) in the final visit.

Third visit: Try in of the restoration according to the guidelines recommended.

Fourth Visit: patients were invited again for final delivery. Patients whose influenced molar gets a class A evaluation according to criteria of the modified USPHS of all criteria evaluated involved in this study.

### Clinical evaluation measures and follow up period

Scientific assessments will be completed at reference and across 36 months following management in accordance with modified USPHS criteria via dual unconnected assessors (Table 3) [30-34]. The assessors completed a regimented exercising schedule before the trial starts. Recurrent caries, Proximal contact, Tooth integrity, and Patient satisfaction were documented and gauged. In accordance with what was positive, the latter were, they were classified into Alpha, Bravo, or Charlie. Each issue was evaluated Alpha (A) in case of no problem, Bravo (B) in case of the lesser degree of the complication, Charlie

(C) if the complication was major or if the restoration had to be removed to repair due to the complication, and Delta (D) or failure when the restoration had to be removed and cannot be repaired. If two assessors report

conflicting estimations through the examination, a 3rd inspector will do an assessment, and the coinciding assessments from two inspectors will be employed for the study.

**Table 3: Modified USPHS criteria.**

No.	characteristic	Rating	Criteria
1	Recurrent caries	Alfa	No recurrent caries
		Bravo	Caries without treatment need
		Charlie	Caries with treatment need
2	Occlusal surface contacts	Excellent	Occlusal contact points on the crown and adjacent teeth, equally strong (both 100- and 12-mm articulating paper imprints exist on the crown and adjacent teeth); no supra- or infraocclusion
		Good	Occlusal contact spots on the crown and adjacent teeth, unevenly strong (only 100-mm articulating paper imprints exist on adjacent teeth)
		satisfactory	Contact points only on the crown (crown too high, thus supraocclusion)
		unsatisfactory	No occlusal contact spots on the crown (infraocclusion)
3	Proximal contact	Alfa	Physiological
		Bravo	Extremely weak (no indication for damage to tooth, gingiva or periodontium > 100 µm)
		Charlie	Extremely weak (indication for damage to tooth, gingiva or periodontium and food impaction)
4	Tooth integrity	Alfa	Complete integrity
		Bravo	Enamel split ≥100um, Crack ≥100um
		Charlie	Major enamel split (dentin exposed), Crack ≥ 200um
5	Patient satisfaction	Alfa	Entirely satisfied
		Bravo	Criticism of esthetic short - N/a Completely coming, lack of chewing
		Charlie	Dissatisfied comfort, time-consuming Procedure

**Data collection**

The researchers utilized a case report form (CRF) (table 1) to gather records for the result investigation. The CRF incorporates demographic information, oral habits, medical history, and undesirable events. To safeguard the secrecy of cases, the patients recorded by the initial letters of their complete name on the model.

endocrowns were clinically inspected through a dental mirror and dental probe and the proximal contact visually checked with a string of waxed dental floss. Then confirmed by periapical x-rays films. The occlusal contact inspected by special articulating papers in static and dynamic mandibular movements. Every variance in contour, restoration outline, and presence of secondary caries as contrasted to reference were notified and documented with digital photography.

A clinical researcher will inspect the obtained records and evaluate the record's credibility by matching the data with the therapeutic data.

The records recorded twice into a database by specified workers and reviewed by a records supervisor (Table 4).

For this study, the first null hypothesis is no statistically significant differences between the evaluated criteria across the follow-up periods, the second null hypothesis is no statistically significant differences between the evaluated criteria related to different restorative endocrown materials used with the age and gender correlated.

**Table 4: Eligibility and follow up periods.**

Assessment for eligibility n=40		
	Enrollment n=40 pt	1 pt excluded, he refused to complete the evaluation period
Allocation baseline assessment		
N=13 by glass-ceramic	N=13 by zirconia polycrystalline	N=13 by PEEK material
Follow up 6 m		
N=13 by glass-ceramic	N=13 by zirconia polycrystalline	N=13 by PEEK material
Follow up 1 year		
N=13 by glass-ceramic	N=13 by zirconia polycrystalline	N=13 by PEEK material
Follow up 18 m		
N= 13 by glass ceramic	N=12 1 restoration debonded	N= 13
Follow up 2 year		
N= 12 1patient lost to follow up due to fracture of the restoration	N=12	N=13
Follow up-to 30 m		
N=12	N=12	N=13
Follow up of 3 years		
N=12	N=12	N=13

### Statistical analysis

The collected data were revised, organized, tabulated, and statistically analyzed using statistical package for social sciences (SPSS) version 26.0 for windows. The records will be investigated by a separate statistician. All statistical tests will be two-tailed. A P-value of less than 0.05 is the level of significance and a 95% confidence interval is calculated. Parametric methods are considered first. Data that do not conform to parametric assumptions or that cannot be transformed are analysed using non-parametric methods.

Based on absolute and relative failures and success rates were calculated. Friedman one sample test will be used for intra-group comparisons, and Friedman two way-Anova two-sample tests will be used for inter-group comparisons. Qualitative variables will be analyzed by the Kruskal-Wallis test. The Bonferroni method will be used for multiple comparisons, and correlation tests to report the effect between all variables will be done.

### RESULTS

The number of cases finally evaluated 39 cases split into three categories consistent with the type of endocrown construction materials and along the following period two male cases rejected after failure and the statistics analysed on the 36 cases with three groups of endocrown materials (a lithium disilicate 12 cases, zirconia 12 case and PEEK group 13 case). These cases distributed among 25 males and 12 females with age range about 39.34 years and there is no effect of age or gender type in the clinical performance.

Absolute failures were defined as clinically unacceptable fracture, which required replacement of the restorations, unacceptable (= Delta rating or unrepaired Charlie rating) untreated secondary caries, restoration fracture, or unrepaired debonding. Relative failures were defined as minimal cohesive fractures and minor cracks, which were clinically acceptable, as well as minor marginal stains and minor deviations in marginal fit or any defect in restoration, which can be repaired intraorally.

After validation, the collected data by SPSS software then exploring it, the data not normally distributed according to Kolmogorov-Smirnov and Shapiro-Wilk tests. For nonparametric data Related-Samples Friedman's Two-Way Analysis of Variance by Ranks was used to compare between more than two groups in related samples. After the rejection of the null hypothesis, the pairwise comparisons between the follow-up period adjusted by the Bonferroni correction for multiple tests. Kruskal Wallis test was used to compare between more than two groups in non-related samples. The significance level was set at  $P \leq 0.05$ . Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows. The logistic regression used to determine the central effect.

The first null hypothesis was rejected by Related-Samples Friedman's Two-Way Analysis of Variance by Ranks as the p-value is less than  $\leq 0.05$ . table. there was a statistically significant difference within all variables; the interproximal contact (IPC), the occlusal surface contact (OSC), secondary caries (SC), the tooth integrity (TI), and the patient satisfaction (PS) through the follow-up periods that extended 36 month (Table 5).

**Table 5: Hypothesis test summary by related samples friedman's two-way analysis of variance by ranks.**

Null Hypothesis	Sig.	Decision
1. The distributions of the interproximal contact at baseline, IPC_6M, IPC_12M, IPC_18M, IPC_24M, IPC_30M, and IPC_36M are the same.	0	Reject the null hypothesis.
2. The distributions of the occlusal surface contact at baseline, OSC_6M, OSC_12M, OSC_18M, OSC_24M, OSC_30M, and OSC_36M are the same.	0	
3. The distributions of secondary caries at baseline, SC_6M, SC_12M, SC_18M, SC_24M, SC_30M, and SC_36M are the same.	0	
4. The distributions of tooth integrity at baseline, TI_6M, TI_12M, TI_18M, TI_24M, TI_30M, and TI_36 are the same.	0	
5. The distributions of patient satisfaction at baseline, PS_6M, PS_12M, PS_18M, PS_24M, PS_30M and PS_36M are the same.	0	

After the rejection of the null hypothesis, the pairwise comparisons between the follow-up period adjusted by the Bonferroni correction for multiple tests. In all variables the first year follow up period, no statistically significant differences presented between the periods. But the statistically significant differences reported between the 18 m and 24m to 30m and 36m in the same related samples.

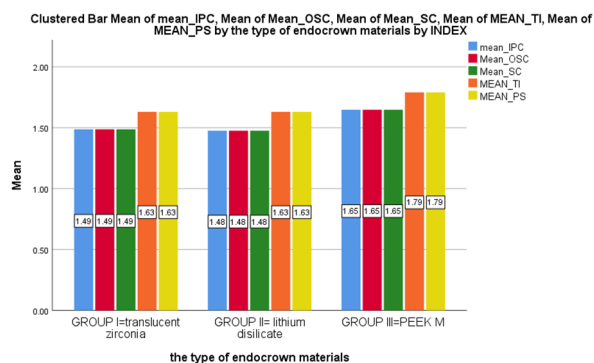
To investigate the statistically significant differences

across the three groups of endocrown materials; group I=translucent zirconia, group II=lithium disilicate, and group III= PEEK material for all criteria tested, Kruskal Wallis test was used to compare between more than two groups in non-related samples. Due to a huge number of results, the mean of all samples in each variable was computed by SPSS software, the Kruskal Wallis test was used to compare between the mean of three groups in non-related samples (Table 6).

**Table 6: Hypothesis test summary by independent-samples kruskal-wallis test.**

Null Hypothesis	Test	Sig.	Decision
The distribution of mean_IPC is the same across categories of the type of endocrown materials.	Independent-Samples Kruskal-Wallis Test	0	Reject the null hypothesis.
The distribution of Mean_OSC is the same across categories of the type of endocrown materials.	Independent-Samples Kruskal-Wallis Test	0	Reject the null hypothesis.
The distribution of Mean_SC is the same across categories of the type of endocrown materials.	Independent-Samples Kruskal-Wallis Test	0	Reject the null hypothesis.
The distribution of MEAN_TI is the same across categories of the type of endocrown materials.	Independent-Samples Kruskal-Wallis Test	0.002	Reject the null hypothesis.
The distribution of MEAN_PS is the same across categories of the type of endocrown materials.	Independent-Samples Kruskal-Wallis Test	0.002	Reject the null hypothesis.

After the rejection of the second null hypothesis, the pairwise comparisons between the three groups adjusted by the Bonferroni correction for multiple tests (Figure 1). The all mean of variables of zirconia group I approximately the same of lithium disilicate group as there was, no statistically significant differences for all ranks, but the two groups statistically different with PEEK group III. the clinical data reported that the best group in group I, group II than group III respectively.



**Figure 1: Clustered bar mean of means of interproximal contact,occlusal surface, secondary**

### **caries, tooth integrity, and patients satisfaction across the three types of endocrown materials.**

By Kendall's Tau correlation, the level of significance  $\leq 0.05$  for the mean of there was a statistically significant difference within all variables; the interproximal contact (IPC), the occlusal surface contact (OSC), secondary caries (SC), the tooth integrity (TI), and the patient satisfaction (PS), but there was no significant relation with the gender of the patient or the age category.

### **DISCUSSION**

In this cohort study of translucent zirconia, lithium disilicate, and modified PEEK endocrown restoring single endodontically lower first posterior teeth, one endocrown fracture, one endocrown deretained, and no teeth damage were found, resulting in a high survival rate (94.87%). Moreover, the practical results estimated by the USPHS criteria were extremely satisfactory too. Consistent with the USPHS criteria, the clinical quality of all endocrowns was in a suitable and preferred range as the first and second null hypotheses were rejected but all cases did not report the failure condition along the examination periods. In some cases, the necessary corrections were accomplished and there was no essential for substitution of the endocrown.

The results of this clinical study agree that CAD-CAM endocrowns are an effective treatment solution for the restoration of extensively damaged endodontically treated molars. Excellent survival rates have been reported (94.87%). Clinical performance is also satisfactory and comparable with that observed for molars restored by using crowns. Also, endocrowns had fewer catastrophic failures 0% of root fractures. two cases considered failures found in two endocrowns were due to loosening (one case from zirconia cases) and fracture in one case of lithium disilicate cases and excluded from evaluation by total (37 case). The sum of patients studied in the present study is concurrent with the present literature [2,31].

Special preparations are recommended for the creation of endocrown. A modification on the design of the endocrown is probable to augment the aesthetics and biomechanical characteristics of the definitive restoration. Along with other factors, the reinforcement material affects the design of the preparation concerning the complete reduction in the height of the occlusal surface. fages et al [30]. advised When endocrown ceramic materials are used as in the present study, it is recommended to reduce the axial direction by at least 2 mm.

Regarding the choice of materials used and related to survival rate due to debonding or irreparable fracture, the modified PEEK materials have some interesting characteristics for endocrown fabrication, thanks to their modulus of elasticity, which is similar to that of dentin and thus limits irreparable fractures, while retaining a high fracture resistance. However, a decrease in elastic modulus reduces stress in the dentin while increasing it

at the interface, thus leading to risks of debonding and detachment of the prosthesis and preservation the tooth integrity, this correlated with the finding of our study where the rate of Bravo and Charlie recorded to all cases at the 36-month examination period [32].

Related to the interproximal criteria, there are no statistically significant differences between zirconia group and lithium disilicate cases as the mean rank 14.25, 13.75 respectively, while the mean rank of PEEK group was 28.23. This mean that the PEEK group progress more from Alpha rating to Charlie rating may be due to less mechanical properties of resin infiltrated ceramic than monolithic zirconia and lithium disilicate materials (Table 2). So cannot withstand the stress as zirconia and lithium disilicate groups.

Regarding, the data of occlusal surface contact support rejection of the null hypothesis for these variables. However, no differences were found in the occlusal relationship between the group, the mean rank of zirconia group was 14.25, lithium disilicate group 13.75, but different with the PEEK group 28.23 including articulating paper examination, maybe because the wear of group III higher than group I, II because the hardness of PEEK material is (2300 MPa VH), whereas, for monolithic zirconia (7000 MPa) and lithium disilicate (6000 MPa).this in agreement to Tang et al. demonstrated the wear produced by the monolithic zirconia crown is greater than the functional wear of natural teeth due to chewing, and the highly polished monolithic zirconia crown is produced much less wear on the enamel evaluated with other ceramic crowns [33].

Furthermore, these results correlated with a study on translucent zirconia that reported by the launch of monolithic restorations in everyday practice, and there was great concern about the destruction of the surface of solid zirconia on antagonistic enamel. The results of RCTs and in vitro studies showed that the wear of the opposite tooth enamel is less with monolithic zirconium oxide compared to the wear of other ceramic crowns [34-37].

In this clinical trial, no significance for using muscle EMG between the endocrown and the opposing natural tooth, since the difference produced by the restoration of a single tooth was not adequate to influence the force of masticatory muscles. Nevertheless, variations in occlusion and masticatory muscle strength are intricately associated when doing different forms of fixed restorations, especially full-mouth rehabilitations, the variations in the masticatory muscles must be considered by dentists [38].

Based on the study conclusions was that the endocrowns produced with the CAD/CAM technology of lithium disilicate and translucent zirconia demonstrates superior anatomic contour and stabilized interproximal contact along the full examination period as rated alpha and Bravo but the cases of modified PEEK materials have good anatomic contour and interproximal contact as rated alpha and Bravo to the 30 months but at 36 month examination period, the cases recorded Charlie rating, this may due to inherent weakness of resinous materials



and residual polymerization shrinkage lead to degradation the material but can be repaired to good contour by addition of resin composite. One more probable clarification to this might be that more than the 1–1.2 mm thickness of the resin nano ceramic CAD/CAM material utilized was not capable to tolerate the vertical and lateral forces (masticatory forces) in the occlusal and interproximal contact, as it receives widespread loadings. This observation agrees with research proving that the anatomy of CAD/CAM derived restorations are more harmonious with the biological morphology of an intact tooth. The harmonic integration of the lithium disilicate as recorded alpha and Bravo only along the full examination period and tooth integrity restorations to the functional form of the residual dentition continued steady above the entire examination period (100% Alpha and Bravo rating). As a result of the progress and improvements in the discipline of CAD/CAM dentistry, it is currently probable to plan and grind meticulous and normal anatomical morphologies, which are even outstanding to conventional wax-up structures designed by dental technicians [39].

Because of the risk of cement breakage due to receiving high load and secondary or recurrent caries interrelated and integrated criteria. although the rejection of the null hypothesis in this study, no secondary caries could be detected at the 12 months examination period for all the tested materials. The good marginal fit and disappearance of secondary caries especially the monolithic zirconia crowns. During the second year the record of Bravo rate increased from lithium disilicate, translucent zirconia and modified PEEK endocrown respectively, this in agreement with in vitro investigations have indicated that the marginal adaptation of the monolithic crowns can be affected by several factors, as the type of preparation, margin outline, and the restoration manufacturing techniques [40,41].

Related to the clinical examination of the current study recorded for secondary caries, the mean rank for the zirconia group was (14.24), lithium disilicate was (13.75) along the 36-month examination time but for modified PEEK endocrown recorded (28.23). no significant differences between group I and II, but lithium group better than zirconia at the same examination period may be due to difficulties in surface treatment and bonding procedure to translucent zirconia, this in disagreement study by Batson et al. evaluated the marginal adaptation between metal ceramic, lithium disilicate, and monolithic single crowns and they showed that the monolithic crowns have considerably superior marginal integration in comparison to lithium disilicate crowns [42]. The less good was the PEEK material may be due to less modulus of elasticity (Table 2). So, transfer more stress to the tooth restoration interface, this led to breakage the bonding layer and the PEEK is radiolucent, which could enable recurring caries discovery [43].

Besides, the fracture resistance observed for the varied materials considered was mainly greater than the masticatory forces. As the risk of debonding is greater than the risk of fracture, materials with the greatest

adhesion values, such as lithium disilicate, are the best choice. Based on, the finding of this study synchronized with this interpretation, whereas the success of lithium disilicate and translucent zirconia endocrowns was 100 % along the 36 months examination period related to bonding but one case fractured may be due high masticatory force or uniaxial force especially the high force at the first molar area and one zirconia case deboned and the two cases rejected from the final assessment, but modified peek endocrowns was 100 % between alpha and Bravo rating 30 months but after that number of cases rated Charlie more than the other cases, however, the satisfaction of patients rated Charlie in 4 cases and these cases repaired to the successor criteria. Collectively the lithium disilicate the best because they have the highest score of alpha rate and Bravo rate more than zirconia and PEEK cases [40,44].

Regarding tooth integrity and patient satisfaction, especially the masticatory function. Our finding of this study founded that there is no statistically significant difference between the zirconia and lithium disilicate tested materials, but significantly different from PEEK group along the three years examination follow up. These results may be due to high modulus of elasticity for translucent zirconia (210 GPa) and lithium disilicate (95 GPa), but, for PEEK material (2.3 GPa), so the PEEK endocrown transfer more stress to the teeth structure than zirconia or lithium disilicate, consequently, more risk and less score for teeth integrity. This compared to a study by CHEN Binwen et al. who reported that ceramic endocrown transferred less stress than composite resin and resin infiltrated ceramics, namely was more protective to the tooth structure [45].

The high level of patient satisfaction in our study is an indicator that the CAD-CAM endocrown constructed from lithium disilicate, translucent zirconia and modified PEEK material is satisfactory and predictable to a high degree, all cases of different materials rated alpha or Bravo except cases of modified peek material at 30 and 36 months rated Charlie due to affected restoration contour and color changes because its low modulus of elasticity and inherent weakness of resinous materials but the patients agree to repair and not remove the restoration this may be due to that the restoration in lower posterior area (not esthetic area), high masticatory forces, no severe defect in function and the fear from tooth affection.

Finally, the best scientific result was detected in the clinical cases that were fabricated from lithium disilicate equal or better slightly than translucent zirconia ceramic but more than the PEEK materials in all the tested criteria After three years, each scientific property was valued as Alfa or Bravo. This outcome reinforces the opinions, reported in numerous clinical articles that the recommended lithium disilicate could be the best desirable materials for the construction of an endocrown because of the establishment of a greater bonding between resin cement and dental tissues, biological and esthetic stability [2,42].

Nevertheless, the organization of the 'material selection' cannot be accomplished because novel creation materials are continually being advanced. In study 2013 concluded that CAD/CAM derived endocrowns made by milling blocks of resin composite (MZ100 blocks, Paradigm, 3M ESPE) showed superior marginal adjustment than leucite reinforced CAD/CAM glass-ceramics (IPS EMPRESS CAD, IVOCLAR VIVADENT) [46].

The recent resin-based ceramics materials display benefits regard to their greater characteristics that be like those of dentin, such as Elastic modulus, less crack spreads, superior fracture resistance as opposed to ceramics that are more liable to fracture because of their brittle nature [47-50]. Conversely, resin composite materials appear to have superior microleakage through the time [51] and are weaker than lithium-disilicate glass ceramic under eccentric loadings [52]. Furthermore, the high survival rates of translucent zirconia endocrown presented in this trial are also confirmed by the outcomes of other trials [42].

All in all, the clinical success of endocrowns of our study for lithium disilicate, translucent zirconia and modified PEEK 94.87% this correlated with a small number of clinical studies accessible currently show the scientific survival percentage of endocrowns that changes from 94 % to 100 % in 36 months<sup>55</sup>, whereas their 10-year success rate was set to 98.8%<sup>56</sup>. In study 2015 deduced that the success rate of Cerec produced feldspathic endocrown in posterior teeth (molar and premolar) was set to 90.5% and 75% respectively, in a 12-year evaluation time.

The lack of standardization among different studies may limit the comparison between outcomes since the performance based on various aspects. These include the category of restoration (crowns, inlays, onlays, and endocrowns), the dissimilar materials verified, the mode of construction, the precision of the scanning and milling systems, the cement space, the size of the milling rotary instrument, and the assessment methods used.

The current investigation has some restrictions (like the sum of participants involved, the short follow-up period, the workflow was not fully digital because the impressions were not taken with intraoral scanners as the application of the clinics method was not the main aim of this trial). Upcoming clinical assessments could adopt the completely digital workflow in combination with the tested materials.

### CONCLUSIONS

Within the limits of this prospective clinical study, CAD/CAM-fabricated endocrowns displayed promising outcomes after a study episode of 3 years, guiding to the deductions that.

- The three types of restoration were a promising substitute and a more minimal invasive restorative regime for Endodontically treated teeth.
- Four principal issues justify for the success and durability of endocrowns: accurate preparation of the

tooth, meticulous choice of restorative and cementing materials, and precise choice of cases comprising tooth type, margin positions, and residual sound dental structures.

- lithium disilicate glass may be the best desirable materials for the construction of an endocrown due to the formation of a greater bond between resin cement and tooth tissues
- the translucent zirconia restorations constructed with CAD/CAM technology is a practical option for the endocrown restoration of single posterior teeth. This study revealed no fracture of single-tooth translucent endocrowns and the success rate was high.
- PEEK might be believed another structure material for endocrowns restoration. The additional long-term clinical proof is needed to determine the use of this material as an alternative for the usual ceramic.

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