

Clinical Performance of One-Piece Molar Endocrowns Fabricated from Different Ceramic Materials: A 36-Month Retrospective Clinical Study

Emad Ahmed Kamli¹, Fadwa Saeed Alasmari², Youssef A Algarni³, Abdulelah Sameer Sindi³, Abdulaziz Mohammed Zailai¹, Razan Abu Alqasem Bosly¹, Maha Nasser Al Lebda⁴, Mushyirah Yahya Sabyei¹, Salha Hussein Alwadei⁵, Abdulsalam Ahmed Alamir¹, Ahmad Abdulrahim Al Aqil¹, Moahmmmed M Al Moaleem⁶

¹Department of Restorative Dentistry, Specialized Jazan Dental Center, Jazan Health Cluster, Jazan, Saudi Arabia; ²Department of Restorative Dentistry, Najran Health Cluster, Najran, Saudi Arabia; ³Department of Restorative Dental Sciences, Endodontic Division, College of Dentistry, King Khalid University, Abha, Saudi Arabia; ⁴Department of Restorative Dentistry, Ahad Rufaidah General Hospital, Asser Health Cluster, Abha, Saudi Arabia; ⁵Department of Restorative Dentistry, College of Dentistry, King Khalid University, Abha, Saudi Arabia; ⁶Department of Prosthetic Dental Science, College of Dentistry, Jazan University, Jazan, 45142, Saudi Arabia

Correspondence: Moahmmmed M Al Moaleem, Department of Prosthetic Dental Science, College of Dentistry, Jazan University, Jazan, 45142, Saudi Arabia, Tel +99550599553, Email malmoaleem@jazanu.edu.sa

Background: This retrospective observational clinical study designed to assess the clinical performance and outcomes of cemented one-piece molar endocrowns (ECs) using the United States Public Health Service (USPHS) criteria at various time intervals. Additionally, patient satisfaction for cemented ECs was measured using the Visual Analog Scale (VAS).

Methods: Clinical data were collected from 29 participants (mean age 26.34 ± 6.99 years) who received ECs at a specialist dental center. Twenty-four ECs were constructed from lithium disilicate glass-ceramic (LDGC) and five from multilayered zirconia. All patients were analyzed at each follow-up (baseline, 6, 12, 24, and 36 months). Clinical performance was evaluated using modified USPHS criteria, and patient satisfaction was measured with a VAS. Statistical analyses included ANOVA and McNemar tests, with significance set at $p \leq 0.05$.

Results: After 36 months most LDGC restorations retained “Alpha” (clinically excellent) scores for marginal adaptation, color match, anatomical form, restoration integrity and retention; zirconia restorations showed a mix of Alpha and Bravo scores. Significant differences between the materials were found for color at baseline ($p=0.001$) and at 36 months ($p=0.018$) and for retention at 36 months ($p=0.001$). Overall patient satisfaction by VAS remained high across groups.

Conclusion: Despite the limitations of a small zirconia sample, LDGC ECs showed better color matching and retention than zirconia. Zirconia is still a viable option where strength is essential. Material selection should consider esthetic demands and occlusal load. Long-term studies with larger cohorts are needed for validation.

Keywords: endocrowns, lithium disilicate, zirconia, molar, USPHS, visual analog scale

Background

Endodontically treated teeth (ETT) are structurally weaker and more susceptible to fracture than vital teeth, due to previous caries, existing restorations, and the loss of tooth structure during endodontic access and shaping.¹ For decades, the standard for restoring ETT with extensive coronal loss has been a full-coverage crown, often used in conjunction with a post and core foundation.²

The introduction of the endocrown (EC) has provided a conservative and effective alternative to traditional post-retained prostheses, particularly for molars.^{3,4} This monolithic restoration leverages the surface area of the pulp chamber

and remaining coronal structure for retention, eliminating the need for a post. The clinical success rate of one-piece ECs is high, reported between 94% and 100% over various follow-up periods, with some studies suggesting superior biomechanical performance and a lower incidence of root fracture compared to conventional crowns.^{5–8}

With the advent of digital dentistry, computer-aided design and computer-aided manufacturing (CAD/CAM) systems have become the primary method for fabricating ECs, ensuring precision in marginal and internal fit.^{9–11} Two of the most prevalent CAD/CAM ceramic materials for monolithic restorations are LDGC and zirconia. While zirconia offers superior fracture toughness and strength, LDGC is often preferred for its excellent optical properties and ability to form a strong adhesive bond with resin cement.^{12–15} Both materials have demonstrated high clinical performance in single crowns, but direct, long-term comparative studies on their use specifically for molar ECs are limited.^{16–20}

United States Public Health Service (USPHS) or “Ryge criteria” are the most public clinical criteria utilized to assess cemented prostheses,^{21,22} and those of the World Dental Federation, which was presented in 2007.²³ These criteria assessed cemented prostheses in relation to their esthetic, biological, and functional characteristics.¹⁴ The USPHS criteria adopt Alpha, Bravo, and Charlie or Delta categories to document different features of the one-piece EC prostheses assessed: Alpha (clinically excellent); Bravo (clinically acceptable); Charlie/Delta (clinically unacceptable, regardless of reparability).^{23,24} Those parameters and standards are easily reproducible and can be tailored to the user’s needs. Those parameters are standards, can be custom-made to the researchers needs, and easily represented.

One-piece EC preparation design does not have a gold standard,⁶ and it influences fracture resistance and marginal adaptation.²⁵ To provide retention and resistance for one-piece EC prostheses, a 2 mm intrapulpal extension followed by a 4 mm mesial and distal groove is highly recommended and can increase the bonding strength of restorations.²⁶ It should have smooth internal preparation, a flat pulpal floor, a 90-degree butt border, a 2–3 mm cuspal reduction, a 6-degree axial wall divergence rather than parallel walls, and supragingival enamel margins.^{25,27} For proper bonding procedures, an isolation with rubber dam is required.⁵ The usual butt joint finish line type is usually advised as it is a simple and produced efficient margin design to preserve tooth structure.²⁵

A group of in-vivo studies observed the clinical outcome and survival rate of ECs on posterior teeth. One-piece ECs on molars among 289 patients were followed-up for 6–36 months and achieved an excellent satisfaction percentage of 98.0%, high clinical survival rate of 97.2%,¹⁶ and survival rate after up to 12 years of 90.5%.²⁸ Other studies recorded a high percentage of one-piece EC success at different time intervals that extend to more than five years.^{7,15,17,29–31} Recently, Hiraba et al 2024 concluded that a high survival rate has been calculated in clinical study.³²

Due to the lack of in-vivo studies on ECs and the consequences of materials used for their constructions, this retrospective study was considered primarily to assess the clinical performance and outcome of cemented ECs using USPHS at different time intervals. This paper also evaluated the patient satisfaction of cemented one-piece EC using the VAS. The null hypothesis of this clinical study is that no statistically significant differences in cemented ECs assessed by either the USPHS or by VAS parameter are observed after different periods recalls in relation to one-piece EC ceramic materials.

Subjects and Methods

Study Design and Setting

This retrospective observational clinical study was conducted to evaluate the clinical performance and patient satisfaction of one-piece molar ECs fabricated from two different ceramic materials. The study was conducted in accordance with the principles of the World Medical Association’s Declaration of Helsinki.³³ Ethical approval for the retrospective analysis of clinical data was granted by the Jazan Health Ethics Committee (No. 2482; 19 November 2024). The requirement for individual patient consent was waived due to the retrospective nature of the study, which involved the analysis of anonymized data extracted from existing clinical records. All clinical data and follow-up assessments utilized in this analysis were obtained from patients who had received treatment and undergone routine follow-up at the specialist dental center between April 2021 and April 2024.

Sample Size and Characteristics

Clinical data were extracted from the center's electronic patient record system, the CS-R4 program. The study population included all patients who had received a ceramic one-piece endocrown on a molar tooth between April 2021 and April 2024 and for whom a complete 36-month follow-up record was available. A post-hoc power analysis was performed using G*Power software, which indicated that the final sample of 29 ECs achieved a power of 81% with an effect size of 0.88, confirming the sample's adequacy for detecting significant differences in the primary outcomes. However, the distribution of restorations reflected the clinical case flow and patients material preferences, resulting in 24 restorations fabricated from LDGC and 5 from multilayered zirconia.

Inclusion and Exclusion Criteria

The study included data from patients of both genders who had received a ceramic one-piece EC on a maxillary or mandibular molar. The included ETT treated teeth had no radiographic evidence of apical periodontitis, internal or external root resorption, and had posterior vertical stops. All cases had been performed by residents in the Department of Restorative Dentistry as part of the Saudi Board program. Only cases with complete clinical records including USPHS evaluation forms, VAS satisfaction surveys, and periapical radiographs from the baseline and all scheduled recall appointments were considered. Cases were excluded from the analysis if patient records indicated parafunctional habits, periapical pathosis at the time of restoration, or the absence of anterior teeth.^{34,35} Cases with incomplete or missing follow-up data were also excluded from the analysis.

Clinical Procedures, Operator Details, and Workflow

All original clinical procedures, including tooth preparation, impressions, and cementation, had been performed by Saudi Board residents in the Department of Restorative Dentistry. A standardized protocol for preparation and cementation had been followed for all cases. The preparation design was consistent with established principles, featuring a 2-mm intrapulpal extension, a flat pulpal floor, and a 90-degree butt-joint margin.^{25,27}

The cementation protocol, as documented in patient records, involved isolation with a rubber dam. The bonding surfaces of all restorations had been treated according to manufacturers' instructions. LDGC restorations were etched with 5% hydrofluoric acid (Porcelain Etch, Bisco, USA) for 20 seconds, rinsed, and dried, followed by the application of a silane coupling agent (Porcelain Primer, Bisco, USA). Zirconia restorations underwent air-borne particle abrasion with 50µm alumina oxide particles and application of a 10-MDP containing zirconia primer (Z-Prime Plus, Bisco, USA). The teeth were etched with 37% phosphoric acid, and a universal adhesive (All-Bond Universal, Bisco, USA) was applied. All restorations were cemented using a dual-cure resin cement (Duo-Link, Bisco, USA).

The clinical and laboratory workflow remained consistent across all cases, as illustrated in [Figure 1](#): (A) pulpal chamber preparation after root canal obturation with flowable composite; (B) final impression; (C) laboratory-fabricated endocrown ready for cementation; (D) tooth isolation; (E-F) post-cementation occlusal examination and adjustment; and (G) post-cementation periapical radiograph. Other representative cases are further illustrated in [Figures 2A–G](#) and [3A–F](#).

Data Collection and Outcome Measures

Data for this study were collected retrospectively from the patients' clinical charts at five distinct time points: baseline (cementation), 6 months, 12 months, 24 months, and 36 months. For every participant, an examination charting sheet was used for each cemented one-piece ED. It involved a short clarification of the aim of the study and the way of data gathering, and groups of questions in addition to the contributor's characteristics were collected. The patient's demographic data as the age of the participant, smoking (yes or no), arch type (maxillary or mandibular) or side (right or left), remaining axial height (1–2 or >2 mm), type of one-piece EC CAD/CAM ceramic material used (LDGC or multilayer zirconia), and the presence of mesial or distal finish-line preparation modification (yes or no).

The primary outcome measure was the clinical performance of the ECs, which had been assessed using a modified United States Public Health Service (USPHS) criteria, as detailed in [Table 1](#) and consistent with previous studies.^{14,19,22,25,36} This form evaluated five parameters: Color match, Retention, Restoration integrity, Marginal



Figure 1 (A) during LDGC endocrown preparation, (B) impression of endocrown, (C) restoration before cementation, (D), acid etching of teeth, (E) cementation of endocrown, (F), during occlusal assessment, (G) preapical x-ray of cemented restoration.

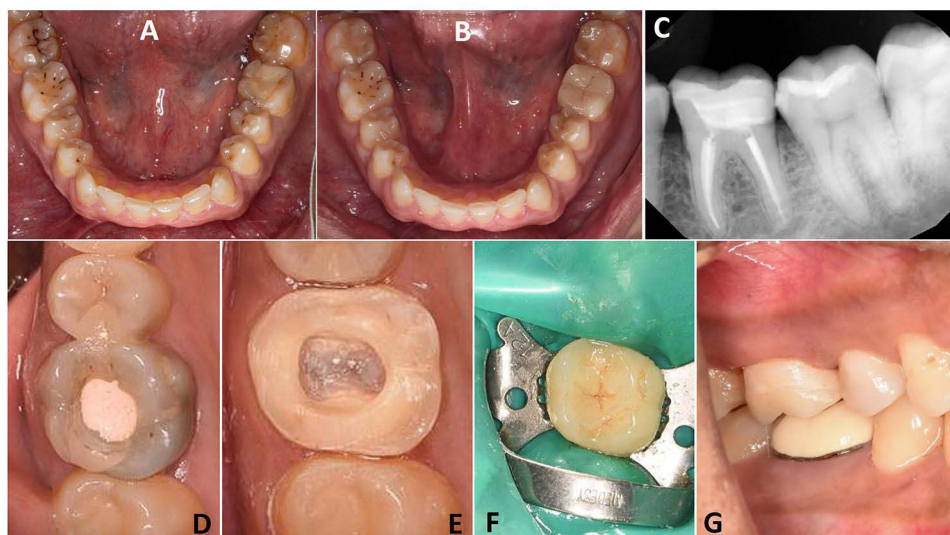


Figure 2 Mandibular left zirconia endocrown (A–C) and maxillary right LDGC endocrown (D–G) 1st molar before and after cementation.

adaptation, and Anatomical form, each rated as Alpha (clinically excellent), Bravo (clinically acceptable), or Charlie/Delta (clinically unacceptable).

The second part assessed and documented the overall patient degree of satisfactions in terms of color, morphology, and margins by using the Visual Analogue Scale, which was graded as very satisfied, satisfied, fairly satisfied, not satisfied, respectively.^{30,37} Two evaluators were collected and recorded the data to measure the reliability and accuracy of the gained results. The clinical performances were assessed and followed-up for USPHS and VAS at baseline and 6,12, 24, and 36 months.

Data Analysis

The collected data from the patients were categorized and analyzed using Statistical Package for Social Science software program version 28.0 (Chicago, Illinois, USA). The mean, frequency, proportions, and standard deviation (SD) were calculated and presented as a descriptive statistical.

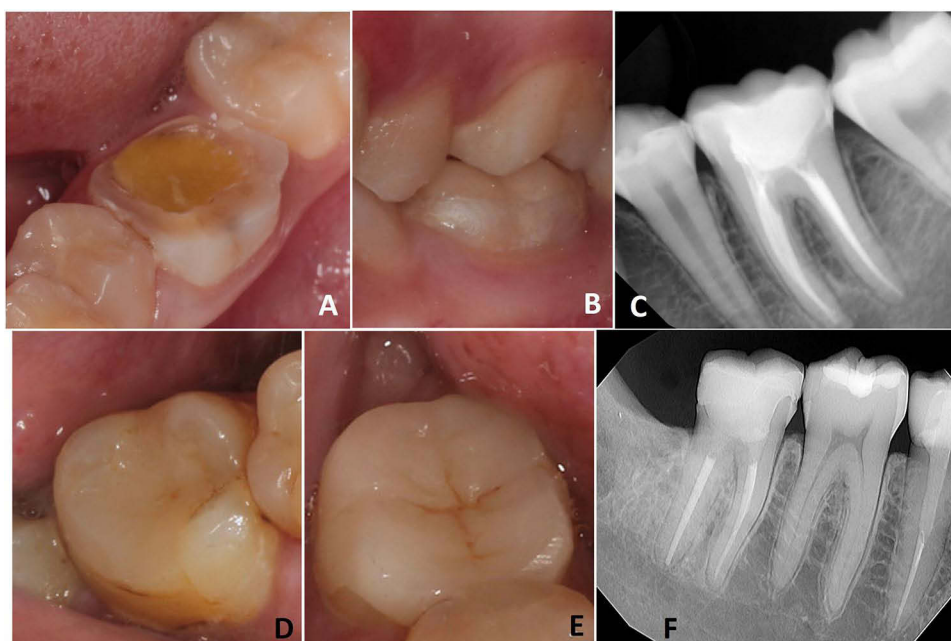


Figure 3 Mandibular left 1st (A–C) and right 2nd (D–F) molar teeth before and after cementation of endocrown.

Associations between the ceramic material used (LDGC vs zirconia) and other variables (arch, side, remaining axial wall height, preparation modifications) with the clinical outcomes were evaluated using ANOVA and the McNemar test, followed by Bonferroni's post hoc test with p value kept at ≤ 0.05 for significance.

Table I Modified United States Public Health Services Criteria Used for Evaluation ECs Prostheses

Parameter	Rating	Restoration Condition
Color match	Alpha	Excellent color match and shade between restoration and adjacent tooth, restoration almost invisible
	Bravo	Slightly mismatching between the restoration and the adjacent tooth, which is in the normal range of tooth
	Charlie/Delta	Color, translucence, and/or shadeObvious mismatch, beyond the normal rangeGross mismatch/aesthetically displeasing colour, shade, and/or translucence.
Retention	Alpha	Complete retention of the restoration
	Bravo	Mobility present
Integrity of restoration	Alpha	Completely intact
	Bravo	Crack apparent on transillumination
	Charlie/Delta	Fracture observableCrown lost (state at which interface debond occurred)
Marginal adaptation.	Alpha	The restoration is continuous with current anatomic form, and the sharp explorer will not catch the smooth margin interface
	Bravo	The sharp explorer catch at a single spots, but there are no observable crevices that the explorer will penetrate
	Charlie/Delta	There is a crevice at the margin, and there is an exposed enamel margin/The crevice at the margin is very apparent, and there is exposed dentine or lute.

(Continued)

Table 1 (Continued).

Parameter	Rating	Restoration Condition
Anatomic form	Alpha	The restoration is continuous with the anatomy of the teeth
	Bravo	Slightly over- or under contoured restoration; slightly under contoured; contact slightly open (maybe self-correcting); locally reduced occlusal height
	Charlie/Delta	Restoration is grossly over- or under contoured, with an exposed base or dentin; faulty contact, ie, not self-correcting; reduced occlusal height; occlusion affectedMarginal overhang present; traumatic occlusion; damaged tooth, supporting bone or soft tissues

Results

A total of 29 one-piece molar ECs were evaluated from 29 participants. The mean age of the participants was 26.34 ± 6.99 years. The demographic and clinical characteristics are summarized in [Figure 4](#). The majority of the participants were non-smokers (86.2%, n=25). Most ECs were placed in mandibular molars (72.4%, n=21), with a slight predilection for the left side (51.7%, n=15). An axial wall height of more than 2 mm was present in 17 cases (58.6%), and mesial/distal preparation modifications were performed in 20 cases (69.0%). Regarding the restorative material, LDGC was used in the majority of cases (82.8%, n=24), while multilayered zirconia was used in 5 cases (17.2%).

The clinical performance of all ECs, as assessed by the modified USPHS criteria at baseline, 6, 12, 24, and 36 months, is detailed in [Table 2](#). Overall, most restorations maintained clinically excellent (Alpha) or clinically acceptable (Bravo) scores throughout the study period. No restorations were rated as clinically unacceptable (Charlie/Delta) at any follow-up point.

A longitudinal analysis revealed subtle changes over 36 months. While anatomical form and restoration integrity remained stable, marginal adaptation ratings shifted from Alpha to Bravo. Alpha scores for marginal adaptation dropped from 89.7% at baseline to 69.0%, and for retention from 100% to 86.2%. The color match parameter showed the most change, with Alpha scores declining from 65.5% at baseline to 48.3% at 24 and 36 months. McNemar tests suggested

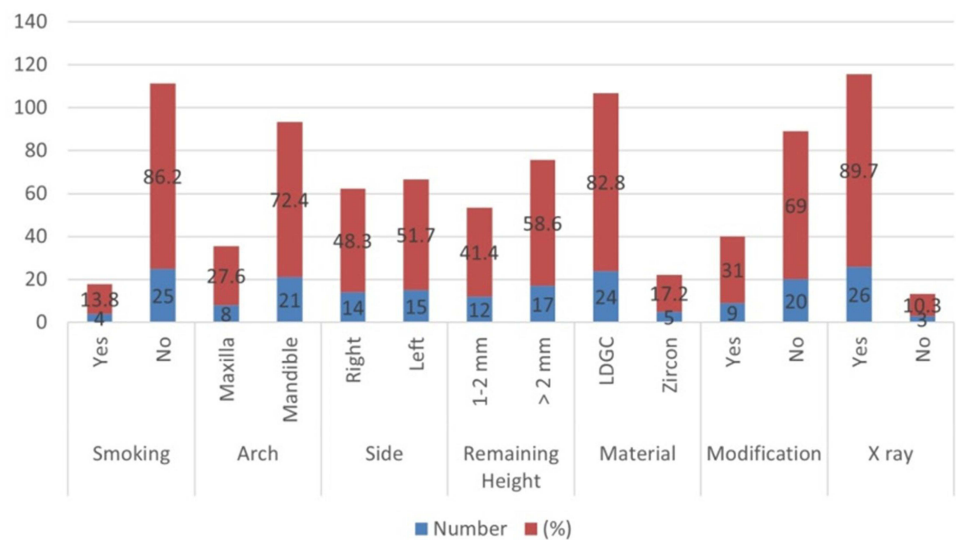


Figure 4 Participants characteristics.

Table 2 Distribution of the Color Match, Retention, Restoration Integrity, Marginal Adaptation, and Anatomical Form in Different Time Points

Variable	Time	Alpha	Bravo	Charlie/Delta	P value*
Color Match	Baseline	19 (65.5)	10 (34.5)	0 (0)	
	6 Months	17 (58.6)	12 (41.4)	0 (0)	0.687
	12 Months	15 (51.7)	14 (48.3)	0 (0)	0.125
	24 Months	14 (48.3)	15 (51.7)	0 (0)	0.063
	36 Months	14 (48.3)	15 (51.7)	0 (0)	0.063
Retention	Baseline	29 (100)	0 (0)	0 (0)	
	6 Months	29 (100)	0 (0)	0 (0)	NC
	12 Months	29 (100)	0 (0)	0 (0)	NC
	24 Months	26 (89.7)	3 (10.3)	0 (0)	NC
	36 Months	25 (86.2)	4 (13.8)	0 (0)	NC
Restoration integrity	Baseline	29 (100)	0 (0)	0 (0)	
	6 Months	29 (100)	0 (0)	0 (0)	NC
	12 Months	29 (100)	0 (0)	0 (0)	NC
	24 Months	28 (96.6)	1 (3.4)	0 (0)	NC
	36 Months	25 (86.2)	4 (15.6)	0 (0)	NC
Marginal Adaptation	Baseline	26 (89.7)	3 (11.3)	0 (0)	
	6 Months	25 (86.2)	4 (13.8)	0 (0)	I
	12 Months	24 (82.8)	5 (17.2)	0 (0)	0.625
	24 Months	23 (79.3)	6 (20.7)	0 (0)	0.375
	36 Months	20 (69)	9 (31)	0 (0)	0.070
Anatomical Form	Baseline	27 (93.1)	2 (6.9)	0 (0)	
	6 Months	27 (93.1)	2 (6.9)	0 (0)	I
	12 Months	27 (93.1)	2 (6.9)	0 (0)	I
	24 Months	26 (89.7)	3 (10.3)	0 (0)	I
	36 Months	26 (89.7)	3 (10.3)	0 (0)	I

Note: *McNemar test; Comparisons were made with the baseline.

Abbreviation: NC, Not calculated.

these changes approached statistical significance for color match ($p=0.063$) and marginal adaptation ($p=0.070$) at 24 and 36 months.

A comparative analysis of the two ceramic materials at baseline and the 36-month recall is presented in Table 3. A highly significant difference in color match was evident between the materials both at baseline ($p=0.001$) and at 36 months ($p=0.018$). At the final recall, 100% ($n=14/14$) of the restorations with an Alpha rating were LDGC, whereas all zirconia restorations (100%, $n=5/5$) received a Bravo (clinically acceptable) rating. None of the zirconia restorations achieved an excellent color score at any evaluation point. A significant difference in retention was also observed at the

Table 3 Distribution of the Color Match, Retention, Restoration Integrity, Marginal Adaptation, and Anatomical Form at Baseline and After 36 Months of Follow-Up by Smoking, Arch, Side, Material, Remaining Height, and Modifications

Variable	Categories	Color Match							
		Baseline				36 Months			
		Alpha	Bravo	Charlie/Delta	P value	Alpha	Bravo	Charlie/Delta	P value [¶]
Smoking	Yes	2 (10.5)	2 (20)	0 (0)	0.482	2 (14.3)	2 (13.3)	0 (0)	0.941
	No	17 (89.5)	8 (80)	0 (0)		12 (85.7)	13 (86.7)	0 (0)	
Arch	Maxilla	3 (15.8)	5 (50)	0 (0)	0.050*	2 (14.2)	6 (40)	0 (0)	0.122
	Mandible	16 (84.2)	5 (50)	0 (0)		12 (85.7)	9 (60)	0 (0)	
Side	Right	10 (52.6)	4 (40)	0 (0)	0.518	9 (64.3)	5 (33.3)	0 (0)	0.096
	Left	9 (47.4)	6 (60)	0 (0)		5 (35.7)	10 (66.7)	0 (0)	
Material	LDGC	19 (100)	5 (50)	0 (0)	0.001*	14 (100)	10 (66.7)	0 (0)	0.018*
	Zircon	0 (0)	5 (59)	0 (0)		0 (0)	5 (33.3)	0 (0)	
Remaining Height	1-2 mm	8 (42.1)	4 (40)	0 (0)	0.913	5 (35.7)	7 (46.7)	0 (0)	0.550
	> 2 mm	11 (57.9)	6 (60)	0 (0)		9 (64.3)	8 (53.3)	0 (0)	
Modification	Yes	7 (36.8)	2 (20)	0 (0)	0.351	5 (35.7)	4 (26.7)	0 (0)	0.559
	No	12 (63.2)	8 (80)	0 (0)		9 (64.3)	11 (73.3)	0 (0)	
Retention									
Smoking	Yes	4 (13.8)	0 (0)	0 (0)	NC	4 (16)	0 (0)	0 (0)	0.398
	No	25 (86.2)	0 (0)	0 (0)		21 (84)	4 (100)	0 (0)	
Arch	Maxilla	8 (27.6)	0 (0)	0 (0)	NC	5 (20)	3 (75)	0 (0)	0.022
	Mandible	21 (72.4)	0 (0)	0 (0)		20 (80)	1 (25)	0 (0)	
Side	Right	14 (48.3)	0 (0)	0 (0)	NC	11 (44)	3 (75)	0 (0)	0.249
	Left	15 (51.7)	0 (0)	0 (0)		14 (56)	1 (25)	0 (0)	
Material	LDGC	24 (82.8)	0 (0)	0 (0)	NC	23 (92)	1 (25)	0 (0)	0.001*
	Zircon	5 (27.2)	0 (0)	0 (0)		2 (8)	3 (75)	0 (0)	
Remaining Height	1-2 mm	12 (41.4)	0 (0)	0 (0)	NC	10 (40)	2 (50)	0 (0)	0.706
	> 2 mm	17 (58.6)	0 (0)	0 (0)		15 (60)	2 (50)	0 (0)	

(Continued)

Table 3 (Continued).

Variable	Categories	Color Match							
		Baseline				36 Months			
		Alpha	Bravo	Charlie/Delta	P value	Alpha	Bravo	Charlie/Delta	P value [¶]
Modification	Yes	9 (31)	0 (0)	0 (0)	NC	8 (32)	1 (25)	0 (0)	0.779
	No	20 (69)	0 (0)	0 (0)		17 (68)	3 (75)	0 (0)	
Restoration integrity									
Smoking	Yes	4 (13.8)	0 (0)	0 (0)	NC	4 (16)	0 (0)	0 (0)	0.389
	No	25 (86.2)	0 (0)	0 (0)		21 (84)	4 (100)	0 (0)	
Arch	Maxilla	8 (27.6)	0 (0)	0 (0)	NC	7 (28)	1 (25)	0 (0)	0.901
	Mandible	21 (80.4)	0 (0)	0 (0)		18 (72)	3 (75)	0 (0)	
Side	Right	14 (48.3)	0 (0)	0 (0)	NC	13 (52)	1 (25)	0 (0)	0.316
	Left	15 (51.7)	0 (0)	0 (0)		12,948)	3 (75)	0 (0)	
Material	LDGC	24 (82.8)	0 (0)	0 (0)	NC	22 (88)	2 (50)	0 (0)	0.062
	Zircon	5 (17.2)	0 (0)	0 (0)		3 (12)	2 (50)	0 (0)	
Remaining Height	1-2 mm	12 (41.4)	0 (0)	0 (0)	NC	10 (40)	2 (50)	0 (0)	0.706
	> 2 mm	17 (58.6)	0 (0)	0 (0)		15 (60)	2 (50)	0 (0)	
Modification	Yes	9 (21)	0 (0)	0 (0)	NC	7 (28)	2 (50)	0 (0)	0.377
	No	20 (79)	0 (0)	0 (0)		18 (72)	2 (50)	0 (0)	
Marginal Adaptation									
Smoking	Yes	2 (7.7)	2 (66.7)	0 (0)	0.005*	2 (10)	2 (22.2)	0 (0)	0.337
	No	24 (92.3)	1 (33.3)	0 (0)		18 (90)	7 (81.8)	0 (0)	
Arch	Maxilla	7 (26.7)	1 (33.3)	0 (0)	0.814	5 (25)	3 (33.3)	0 (0)	0.642
	Mandible	19 (73.1)	2 (66.7)	0 (0)		15 (75)	6 (66.7)	0 (0)	
Side	Right	12 (46.2)	2 (66.7)	0 (0)	0.501	10 (50)	4 (44.4)	0 (0)	0.782
	Left	14 (53.8)	1 (33.1)	0 (0)		10 (50)	5 (55.6)	0 (0)	
Material	LDGC	21 (80.8)	3 (100)	0 (0)	0.404	15 (75)	9 (100)	0 (0)	0.099
	Zircon	5 (19.2)	0 (0)	0 (0)		5 (25)	0 (0)	0 (0)	
Remaining Height	1-2 mm	10 (38.5)	2 (66.7)	0 (0)	0.348	7 (35)	5 (55.6)	0 (0)	0.298
	> 2 mm	16 (61.5)	1 (33.3)	0 (0)		13 (65)	4 (44.4)	0 (0)	
Modification	Yes	8 (30.8)	1 (33.3)	0 (0)	0.928	5 (25)	4 (44.4)	0 (0)	0.295
	No	19 (69.2)	2 (66.7)	0 (0)		15 (75)	5 (55.5)	0 (0)	
Anatomical Form									
Smoking	Yes	4 (14.8)	0 (0)	0 (0)	0.558	3 (11.5)	1 (33.3)	0 (0)	0.300
	No	23 (85.8)	0 (0)	0 (0)		23 (88.5)	2 (66.7)	0 (0)	

(Continued)

Table 3 (Continued).

Variable	Categories	Color Match							
		Baseline				36 Months			
		Alpha	Bravo	Charlie/Delta	P value	Alpha	Bravo	Charlie/Delta	P value [¶]
Arch	Maxilla	8 (29.6)	0 (0)	0 (0)	0.366	6 (23.1)	2 (66.1)	0 (0)	0.110
	Mandible	19 (70.4)	2 (100)	0 (0)		20 (76.9)	1 (33.3)	0 (0)	
Side	Right	13 (48.1)	1 (50)	0 (0)	0.960	12 (46.2)	2 (66.7)	0 (0)	0.501
	Left	14 (51.9)	1 (50)	0 (0)		14 (55.8)	1 (33.3)	0 (0)	
Material	LDGC	23 (85.2)	1 (50)	0 (0)	0.204	22 (84.6)	2 (66.7)	0 (0)	0.436
	Zircon	4 (14.8)	1 (50)	0 (0)		4 (15.4)	1 (33.3)	0 (0)	
Remaining Height	1-2 mm	12 (44.4)	0 (0)	0 (0)	0.218	12 (46.2)	0 (0)	0 (0)	0.124
	> 2 mm	15 (54.6)	2 (100)	0 (0)		14 (53.8)	3 (100)	0 (0)	
Modification	Yes	9 (33.3)	0 (0)	0 (0)	0.326	8 (30.8)	1 (33.3)	0 (0)	0.928
	No	18 (66.7)	2 (100)	0 (0)		18 (69.2)	2 (66.7)	0 (0)	

Note: [¶]Significant differences.

Abbreviations: Chi-square test; NC, Not calculated.

36-month recall ($p=0.001$). The LDGC group demonstrated superior retention, with 95.8% ($n=23/24$) of restorations maintaining an Alpha score. In contrast, only 40% ($n=2/5$) of zirconia ECs retained an Alpha score, with 60% ($n=3/5$) receiving a Bravo rating. For anatomical form, marginal adaptation, and restoration integrity, no statistically significant differences were found between LDGC and zirconia at 36 months ($p>0.05$).

Other factors, such as smoking status, arch (maxillary/mandibular), side (right/left), remaining axial wall height, and the presence of preparation modifications, were also analyzed (Table 3). At baseline, smokers showed significantly worse marginal adaptation than non-smokers ($p=0.005$), though this difference was not sustained at 36 months. No other patient or preparation-related variables demonstrated a significant or consistent association with the clinical outcomes of the ECs.

The overall participant satisfactions of the cemented ECs using VAS ranged between very satisfied and satisfied in color, morphology, and margin throughout the different re-assessment intervals. The color parameter score reduced from 29 cemented ECs to 17 and 16 into the category of satisfied after 24 and 36 months, respectively. A drop from very satisfied to satisfied scale was noted in participant satisfaction in relation to the morphology parameters at the same period follow up (21 out of 29 cases). In relation to one-piece EC margin criteria's, fairly satisfied was documented in two ECs at the time of cementation, and all one-piece ECs were unchanged during the follow-up intervals, as shown in Figure 5.

Discussion

This 36-month retrospective study evaluated the clinical performance of one-piece molar ECs fabricated from LDGC and multilayered zirconia. Overall, no statistically significant differences were found between the materials for anatomical form, marginal adaptation, and restoration integrity parameters indicates that from a purely mechanical and structural perspective, both materials perform adequately over the 36-month period, leading to a partial rejection of the null hypothesis. The slight decline in marginal adaptation scores across both groups is a common finding in longitudinal studies of cemented restorations and is likely related to factors like wear of the luting cement or minor tooth flexure, rather than being a material-specific issue.^{7,17}

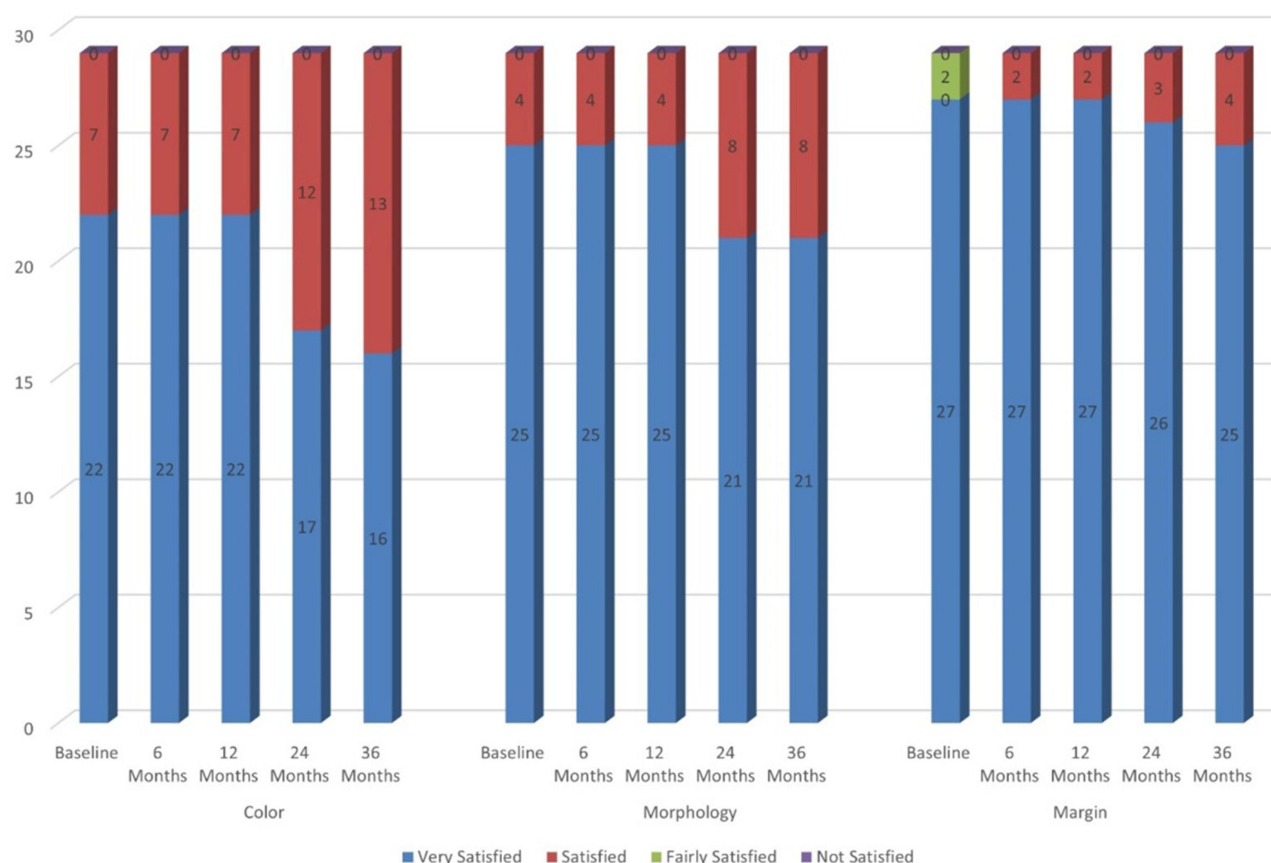


Figure 5 Patient satisfaction according to VAS in relation to color, morphology, and margin in different time points.

These findings are consistent with Alshehri et al, who reported lithium disilicate and monolithic zirconia restorations as excellent after 12 months.¹⁴ Monolithic zirconia one-piece EC also received excellent ratings after 36 months.¹⁶ Liu et al noted 100% excellent restorations for lithium disilicate ECs,²⁹ while Duraisamy et al recorded excellent ratings at baseline and 6 months, transitioning to excellent and clinically acceptable at 12 months.⁷

In relation to the integrity of one-piece EC restorations, both groups of the current study found 100% excellent restoration scores at baseline and 6 and 12-months, which was consistent with another clinical study carried by Do et al, which documented an excellent restoration score in the same duration.³⁰ As the success rate slightly decreased in this study to 96.6%, comparable findings at 12 months were recorded by Do et al (98.2%). According to Salem et al, all lithium disilicate and hybrid nanoceramic EC exhibited excellent restoration scores at baseline and after 12, 24, and 36 months.³¹ Their outcomes were consistent with those of ECs constructed by lithium disilicate materials in the present study.

The observed superiority of LDGC in color match was statistically significant ($p=0.018$ at 36 months) and clinically evident, as no zirconia restoration achieved an “Alpha” rating at any evaluation point. This is not a failure of the zirconia material, but a reflection of its inherent material properties. The polycrystalline structure of zirconia is inherently more opaque and less translucent than the glass-ceramic matrix of LDGC.^{13,18} The baseline color match for the two materials was verified by 65.5% excellent restoration scores, but the clinically acceptable scores increased with time. Those findings closely resembled the 24-month clinical trial by El-Ma’aita et al that was conducted for the same materials.¹⁷

Another finding was the significant difference in retention at 36 months ($p=0.001$). The LDGC group maintained a 95.8% “Alpha” rating, compared to only 40% for zirconia in agreement with a previous clinical study conducted by El-Ma’aita et al and Do et al.^{17,30} This discrepancy is likely attributable to differences in the adhesive interface rather than the mechanical strength of the materials. LDGC can be effectively etched with hydrofluoric acid, creating a micro-

retentive surface that facilitates a strong, durable micromechanical bond with resin cements.¹⁷ In contrast, bonding to zirconia relies on alternative surface treatments, and the long-term stability of the zirconia-resin cement bond under cyclic occlusal loading may be less predictable.³¹

While these differences in color and retention are clinically relevant for aesthetics and longevity, it is crucial to interpret the “Bravo” ratings for zirconia retention correctly: these restorations were all still in place and fully functional, indicating clinical acceptability rather than failure.

Concerning patient satisfaction with the VAS scale, our study showed that most patients were very satisfied in all parameters. This result was similar to the high satisfaction mentioned in other EC clinical studies.^{7,16,29,30} Patients in this clinical study reported less satisfaction with the color and morphology of zirconia compared with lithium disilicate. These outcomes aligned with a previous clinical study.¹⁷ According to De Angelis et al, patients expressed lower levels of satisfaction with monolithic zirconia restorations compared with bilayer zirconia restorations.³⁸ A similar finding was documented after a 2-year recall for lithium disilicate ceramic ECs.³⁰

The current clinical study has several limitations that may have affected the outcomes. One notable factor is the small patient group, which was unevenly distributed between the LDGC and zirconia groups, reducing statistical power and increasing the risk of Type II errors. Additionally, while the 36-month follow-up provided valuable medium-term data, it is insufficient to assess long-term factors such as material fatigue, marginal degradation, and adhesive stability. Consequently, the long-term survival of the ECs and participant satisfaction remain unknown. Future studies should aim for larger, balanced samples and extend the follow-up period to 5–10 years to better evaluate these aspects.

Conclusion

According to this clinical study, the following conclusion can be documented: LDGC remains the preferable option when aesthetic integration and bonding retention are priorities, while zirconia continues to be a viable alternative for patients needing greater fracture resistance. Overall participant satisfaction is high according to VAS. These findings are promising but should be interpreted with caution; they require validation through long-term, large-scale randomized controlled trials to establish robust clinical guidelines for material selection in endocrown restorations.

Patient Permission/Consent Declarations

An ethical approval will be submitted upon request.

Acknowledgment

This work was done at the Department of Restorative Dentistry, Specialized Jazan Dental Center, Jazan Health Cluster, Saudi Arabia.

Funding

There is no funding to report.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Silva LR, de Lima KL, Santos AA, et al. Dentin thickness as a risk factor for vertical root fracture in endodontically treated teeth: a case-control study. *Clin Oral Investig.* 2021;25(3):1099–1105. doi:10.1007/s00784-020-03406-1
2. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). *Quintessence Int.* 2008;39(2):117–129. PMID: 18560650.
3. Thomas RM, Kelly A, Tagiyeva N, Kanagasasingam S. Comparing endocrown restorations on permanent molars and premolars: a systematic review and meta-analysis. *Br Dent J.* doi:10.1038/s41415-020-2279-y
4. AlDabeeb DS, Alakeel NS, Al Jfshar RM, Alkhalid TK. Endocrowns: indications, preparation techniques, and material selection. *Cureus.* 2023;15(12):e49947. doi:10.7759/cureus.49947
5. Govare N, Contrepolis M. Endocrowns: a systematic review. *J Prosthet Dent.* 2020;123(3):411–418.e9. doi:10.1016/j.prosdent.2019.04.009
6. Ciobanu P, Manziuc MM, Buduru SD, Dudea D. Endocrowns - a literature review. *Med Pharm Rep.* 2023;96(4):358–367. doi:10.15386/MPR-2581

7. Duraisamy P, Chander NG, Reddy JR, Balasubramaniam M. The impact of extended pulp chamber preparations on the clinical performance of endocrowns in Indian patients: a 1-year observational study. *J Oral Biol Craniofac Res.* **2023**;13(5):616–621. doi:10.1016/j.jobcr.2023.07.006
8. Lenz U, Bacchi A, Della BA. Biomechanical performance of endocrown and core-crown restorations: a systematic review. *J Esthet Restor Dent.* **2024**;36(2):303–323. doi:10.1111/jerd.13119
9. Al-Dabbagh RA. Survival and success of endocrowns: a systematic review and meta-analysis. *J Prosthet Dent.* **2021**;125:415.e1–415.e9. doi:10.1016/J.PROS-DENT.2020.01.011
10. Sevimli G, Cengiz S, Oruc MS. Endocrowns: review. *J Istanbul Univ Fac Dent.* **2015**;49(2):57–63. doi:10.17096/jiufd.71363
11. Al Moaleem MM, Al Ahmari NM, Alqahtani SM, et al. Unlocking endocrown restoration expertise among dentists: insights from a multi-center cross-sectional study. *Med Sci Monit.* **2023**;29:e940573. doi:10.12659/MSM.940573
12. Al Ahmari NM, Gadah TS, Wafi SA, et al. Relationship between tooth type and material used in the construction of endocrowns and fracture force values: a systematic review. *Eur. Rev Med Pharmacol Sci.* **2023**;27(16):7665–7679. doi:10.26355/eurrev_202308_33420
13. Zhang F, Reveron H, Spies BC, Van Meerbeek B, Chevalier J. Trade-off between fracture resistance and translucency of zirconia and lithium-disilicate glass ceramics for monolithic restorations. *Acta Biomater.* **2019**;91:24–34. doi:10.1016/j.actbio.2019.04.043
14. Alshehri A, Al Moaleem M. Effect of social habits on the clinical performance of CAD/CAM ceramic prosthesis fabricated from different ceramic materials: 12-month follow-up. *Open Dent J.* **2025**;19:e18742106366982. doi:10.2174/0118742106366982250212061501
15. Tammam RA. Clinical evaluation of monolithic Zirconia (5Y), Lithium Disilicate and modified PEEK CAD-CAM endocrown materials, 3-year clinical prospective study. *Egypt Dental J.* **2021**;67(1):635–650. doi:10.21608/edj.2020.37997.1193
16. Zou Y, Bai J, Xiang J. Clinical performance of CAD/CAM-fabricated monolithic zirconia endocrowns on molars with extensive coronal loss of substance. *Int J Comput Dent.* **2018**;21(3):225–232. PMID: 30264051.
17. El-Ma'aaita A, Al-Rabab'ah M, Abu-Awwad M, Hattar S, Devlin H. Endocrowns clinical performance and patient satisfaction: a randomized clinical trial of three monolithic ceramic restorations. *J Prosthodont.* **2022**;31(1):30–37. doi:10.1111/jopr.13414
18. Manso AP, Silva NR, Bonfante EA, Pegoraro TA, Dias RA, Carvalho RM. Cements and adhesives for all-ceramic restorations. *Dent Clin North Am.* **2011**;55(2):311–332. doi:10.1016/j.cden.2011.01.011
19. Al-Hamzi MA, Al-Badani ITH, Al Kbous EHM, et al. Twelve-month clinical outcomes of zirconia cores veneered with lithium disilicate crowns: a retrospective study. *J Contemp Dent Pract.* **2025**;26(6):540–550. doi:10.5005/jp-journals-10024-3890
20. Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: single crowns (SCs). *Dent Mater.* **2015**;31(6):603–623. doi:10.1016/j.dental.2015.02.011
21. Ryge G. Clinical criteria. *Int Dent J.* **1980**;30:347–358.
22. Bayne SC, Schmalz G. Reprinting the classic article on USPHS evaluation methods for measuring the clinical research performance of restorative materials. *Clin Oral Investig.* **2005**;9(4):209–214. doi:10.1007/s00784-005-0017-0
23. Hickel R, Roulet JF, Bayne S, et al. Recommendations for conducting controlled clinical studies of dental restorative materials. Science Committee Project 2/98–FDI World Dental Federation study design (Part I) and criteria for evaluation (Part II) of direct and indirect restorations including onlays and partial crowns. *J Adhes Dent.* **2007**;9 Suppl 1:121–147. PMID: 18341239.
24. Abd Alraheem I, Al-Asmar A, Hasan N, Asoleihat F, Alkayed A. Clinical evaluation of cemented and adhesively resin-bonded monolithic and partially layered zirconia and lithium disilicate crowns. *Saudi Dent J.* **2023**;35(5):508–514. doi:10.1016/j.sdentj.2023.04.001
25. Mostafavi AS, Allahyari S, Niakan S, Atri F. Effect of preparation design on marginal integrity and fracture resistance of endocrowns: a systematic review. *Front Dent.* **2022**;19:37. doi:10.18502/fid.v19i37.11250
26. Al Ahmari NM, Alshehri AH, Gadah TS, et al. Comparison of color changes, fracture strengths, and failure modes of conventional endocrowns and endocrowns with different design modifications. *Technology Health Care.* **2024**;1–14. doi:10.3233/THC-23117
27. Einhorn M, DuVall N, Wajdowicz M, Brewster J, Roberts H. Preparation ferrule design effect on endocrown failure resistance. *J Prosthodont.* **2019**;28(1):e237–e242. doi:10.1111/jopr.12671
28. Otto T, Mörmann WH. Clinical performance of chairside CAD/CAM feldspathic ceramic posterior shoulder crowns and endocrowns up to 12 years. *Int J Comput Dent.* **2015**;18(2):147–161. PMID: 26110927.
29. Liu C, Yang S, Chu X. clinical effect of feldspar glass ceramics and lithium disilicate reinforced glass ceramics. *Contrast Media Mol. Imaging.* **2022**;2022:9691594. doi:10.1155/2022/9691594
30. Do TT, Trinh TM, Tran TTP, Nguyen VTT, Le LN. Clinical performance of computer-aided design/computer-aided manufacture lithium disilicate ceramic endocrown restorations: a 2-year study. *J Conserv Dent Endod.* **2024**;27(1):51–56. doi:10.4103/JCDE.JCDE_99_23
31. Salem MA, Ibrahim SH, Abou-Steit SS. Three Years Clinical Evaluation of Lithium Disilicate and Hybrid Nano-ceramic CAD/CAM Endocrowns (Randomized Clinical Trial). *Egyptian. Dental Journal.* **2024**;70(1):551–561. doi:10.21608/edj.2023.251850.2805
32. Hiraba H, Nishio K, Takeuchi Y, Ito T, Yamamoto T, Kamimoto A. Application of one-piece endodontic crowns fabricated with CAD-CAM system to molars. *Jpn Dent Sci Rev.* **2024**;60:81–94. doi:10.1016/j.jdsr.2023.12.005
33. World Medical Association. World medical association declaration of helsinki: ethical principles for medical research involving human subjects. *JAMA.* **2013**;310(20):2191–2194. doi:10.1001/jama.2013.281053
34. Ozisci O, Kucukmesmen HC. Evaluation of color change before and after polymerization of laminate veneer restorations: a clinical study. *Niger J Clin Pract.* **2022**;25(6):841–848. doi:10.4103/njcp.njcp_1814_21
35. Abu-Hossin S, Onbasi Y, Berger L, et al. Comparison of digital and visual tooth shade selection. *Clin Exp Dent Res.* **2023**;9(2):368–374. doi:10.1002/cre2.721
36. Durão MA, Andrade AKM, Mdcmds S, Montes MAJR, Monteiro G. clinical performance of bulk-fill resin composite restorations using the united states public health service and federation dentaire internationale criteria: a 12-month randomized clinical trial. *Eur J Dent.* **2021**;15(2):179–192. doi:10.1055/s-0040-1718639
37. Chander NG. Visual analog scale in prosthodontics. *J Indian Prosthodont Soc.* **2019**;19:99–100. doi:10.4103/jips.jips_94_19
38. De Angelis P, Gasparini G, Rella E, et al. Patient satisfaction with implant-supported monolithic and partially veneered zirconia restorations. *Biomed Res Int.* **2021**;2021:6692939. doi:10.1155/2021/6692939

Clinical, Cosmetic and Investigational Dentistry**Dovepress**

Taylor & Francis Group

Publish your work in this journal

Clinical, Cosmetic and Investigational Dentistry is an international, peer-reviewed, open access, online journal focusing on the latest clinical and experimental research in dentistry with specific emphasis on cosmetic interventions. Innovative developments in dental materials, techniques and devices that improve outcomes and patient satisfaction and preference will be highlighted. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/clinical-cosmetic-and-investigational-dentistry-journal>