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Clinical Performance of Computer- Aided Design/ Computer-Aided Manufacturing Ceramic Endocrowns on Posterior Endodontically Treated Teeth: A Retrospective Study

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Abstract

Objectives: This study aimed to retrospectively evaluate computer- aided design/ computer-aided manufacturing (CAD/CAM) ceramic endocrowns placed on posterior endodontically treated teeth (ETT) with a mean observation period of 15 months. The impact of residual tooth structure on restoration failure was assessed. Additionally, secondary clinical parameters including restoration material, tooth type, cement type, jaw, facet wear, temporomandibular disorders (TMD), bruxism, plaque index, gingival index, and probing depth were recorded and analyzed for possible association with failure.

Materials and Methods: A total of 92 posterior endocrowns [in 79 patients], each covering at least one cusp, were evaluated. Esthetic, functional, and biological characteristics were assessed using the Federation Dentaire Internationally (FDI) criteria to determine success and survival rates. Restorations were categorized into three groups (Class I-III) based on residual tooth structure after preparation, and failure was analyzed using binary logistic regression. Secondary parameters were obtained from clinical records and examinations, and their association with failure was also evaluated using logistic regression. These included the presence of facet wear, TMD, bruxism, plaque index, gingival index, and probing depth. A p-value < 0.05 was considered statistically significant.

Results: After a mean follow-up of 15.61 ± 8.4 months (range: 2-36 months), 10 endocrowns failed. The success and survival rates were 89.1% and 95.7%, respectively. Among all variables, only plaque index showed a statistically significant association with restoration failure.

Conclusions: CAD/CAM ceramic endocrowns proved to be a reliable and conservative treatment option for restoring ETT.

Clinical significance: When appropriately indicated, endocrowns should be considered a conservative and esthetic alternative to conventional post–core crowns for ETT. Clinicians should also emphasize the importance of optimal oral hygiene, as a higher plaque index was significantly associated with restoration failure.

Keywords: Computer-Aided Design; Computer-Aided Manufacturing; Ceramics; Endocrown; Clinical study

Introduction

When a tooth has suffered extensive coronal destruction due to caries, trauma, or endodontic treatment, its strength and sensory feedback are markedly reduced [1-3]. Selecting an appropriate long-term restorative approach depends on the amount and quality of remaining tooth structure [4,5]. Historically, post-and-core restorations-particularly cast metal post-and-cores have been the standard for retaining crowns on endodontically treated teeth [ETT] [6,7]. Despite their clinical success, cast metal systems require excessive removal of tooth structure and possess an elastic modulus different from dentin, increasing the risk of unfavorable or catastrophic fractures [2,7,8]. With the advent of adhesive dentistry and reinforced ceramics, the endocrown emerged as a conservative alternative for ETT with sufficient pulpchamber depth [9]. First introduced by Pissis et al. in 1995 as a metal free monoblock restoration [10], endocrowns provide improved stress distribution and marginal fit by avoiding the root-canal space [7,11]. They also require less tooth preparation while offering high strength [8,9,12-14], can be fabricated rapidly via an esthetic CAD/CAM workflow [15], and perform predictably in cases of limited clinical crown height, reduced inter-occlusal space, or short and curved canals [16,17]. Comparative studies have demonstrated that CAD/CAM ceramic endocrowns have higher fracture strength and adaptation than conventionally fabricated endocrowns [18,19]. Multiple investigations also report similar or superior performance of endocrowns versus post core crowns in posterior teeth [2,8,13,16,20,21]. Although the clinical success of endocrowns has been well documented, consensus is lacking on how residual tooth structure influences the failure of posterior CAD/CAM ceramic endocrowns. Therefore, this study was designed to evaluate the effect of residual tooth structure on endocrown failure and to determine success and survival rates of posterior CAD/CAM ceramic endocrowns using the FDI criteria [22]. Secondary variables including restoration material, tooth type, cement type, jaw, and presence of facet wear, temporomandibular disorders (TMD), bruxism, plaque index, gingival index, and probing depth were recorded and analyzed using binary logistic regression.

The study hypotheses were:

1. Posterior CAD/CAM ceramic endocrowns have high success and survival rates
2. Amount of residual tooth tissue does not affect the clinical performance.
3. Secondary clinical variables influence endocrown performance.

Material and Methods

This retrospective clinical record evaluation included posterior CAD/CAM ceramic endocrowns covering at least one cusp. The Ethics Committee approved the study (IR.TUMS.VCR.REC.1397.919; 2019/02/16). Patients treated by three experienced prosthodontists at a private prosthodontics clinic between January 2018 and February 2021 were recruited. Patients were selected according to the following inclusion criteria and exclusion criteria (Table 1).

After a pilot study of 20 restorations (p=0.15; confidence limits=0.15, α=0.05), the minimum sample size was calculated as 87 using the PASS 11 “confidence intervals for one proportion” module. During annual follow-up visits, eligible patients were invited to participate in the study; 79 patients (92 endocrowns) met the inclusion and exclusion criteria and were enrolled. All patients provided written informed consent. Some patients had a single endocrown, whereas others received two. Clinical evaluation was performed by two independent operators calibrated with intraoral photographs of 10 partial ceramic using FDI criteria [22]. Both operators had to agree on each score. Restorations were assessed in three dimensions of esthetics, functional, and biologic. Esthetics included surface luster, staining, color match, and anatomical form. Function comprised retention, marginal adaptation, occlusal contour and wear, anatomical form, radiographic examination, and patient view. Biologic evaluation included recurrence of caries, tooth integrity, periodontal response, adjacent mucosa, and oral and general health (the tooth sensitivity feature was excluded because all samples were ETT). Radiography evaluation used bitewing and periapical radiographs (bisecting-angle technique), unless margins were clinically accessible. Each FDI item was scored on a 5-point Likert scale (1 = clinically excellent (very good); 2 = good; 3 = sufficient/satisfactory; 4 = unsatisfactory; 5 = poor (replacement required)). Scores of 4 or 5 were classified as failures. Success was defined as scores of 1–3. Survival was defined as the restoration remaining in place, intact or with minor repairs (scores < 4). Any restoration with at least one item scored 4 or 5 was considered a failure. Endocrowns were classified into three categories based on the amount of residual tooth structure following preparation. In Class I, at least two cuspal walls retained more than half of their original height. In Class II, at most one cuspal wall had more than half of its original height. In Class III, all cuspal walls had been reduced by more than half of their original height [23]. Classification of the restorations was determined from each patient’s stored standard tessellation language (STL) files. These files were generated from digital impressions captured with a CEREC Prime Scan scanner (Dentsply Sirona, USA) [23]. Secondary parameters including restoration material, tooth type, type of cement, and jaw for each restoration were recorded from clinical records. Facet wear, TMD, and bruxism were evaluated based on their presence or absence in the patient through clinical examination. Plaque and gingival indices were assessed intraorally using Loe and Silness index [24,25]. Probing depth was measured using a periodontal probe by walking it around the gingival margins [26]. Data analysis was performed with Statistical Package for the Social Sciences (SPSS) (IBM Corp, v26.0, NY, USA).

Results were presented as frequency tables, success rates, and survival rates. Binary logistic regression evaluated the effects of classification and secondary clinical parameters on the endocrown failure. A p-value < 0.05 was considered statistically significant.

Results

Seventy-nine patients (92 endocrowns) were enrolled: 24 men and 55 women, with a mean age of 42.2 ± 10.3 years (range 19–66). The mean follow-up period was 15.6 ± 8.4 months (range 2–36 months; some restorations had < 12 months of follow-up). Of all restorations, 46% were Class I, 35 % Class II, and 19 % Class III. The frequencies of other clinical parameters appear in table 2, and the FDI ratings for each restoration are shown in (Tables 2,3).

Table 1: *Inclusion and exclusion criteria.*

Inclusion criteria	Exclusion criteria
Participants aged ≥ 18 years	Participants who declined to sign the consent form
Molar or premolar teeth	Radiographic or clinical evidence of periapical lesions at follow-up
Teeth with completed root canal treatment	Uncooperative patients who refused to participate
Supragingival margin	Teeth lacking natural antagonists or adjacent teeth
	Severe periodontitis

Table 2: *Clinical parameters frequency.*

Variable		Frequency	Valid percent
Tooth type	First premolar	7	7.6
	Second premolar	15	16.3
	First molar	45	48.9
	Second molar	25	27.2
Jaw	Maxilla	47	51.1
	Mandible	45	48.9
Classification	Class I	42	45.7
	Class II	32	34.8
	Class III	18	19.5
Material	IPS emax	43	46.7
	Vitamark II	13	14.1
	IPS empress	2	2.2
	CEREC block	25	27.2
	Celtra duo	8	8.7
	Other (Rossetta)	1	1.1

Type of cement	Panavia F2	7	7.6
	Panavia universal	5	5.4
	Panavia V5	80	87
Existence of facet wear	No	89	96.7
	Yes	3	3.3
TMD	No	87	94.6
	Yes	5	5.4
Bruxism	No	85	92.4
	Yes	7	7.6
Plaque index	0	75	81.5
	1	14	15.2
	2	3	3.3
Gingival index	0	84	91.3
	1	8	8.7
Probing depth	0-1	27	29.4
	1-2	35	38
	2-3	30	32.6

Table 3: *Endocrowns rating by FDI criteria.*

FDI parameter	Excellent% (n)	Good% (n)	Satisfactory% (n)	Unsatisfactory% (n)	Poor% (n)
Surface luster	66.3 (61)	31.5 (29)	2.2 (2)	0 (0)	0 (0)
Staining	73.6 (67)	23.1 (21)	3.3 (3)	0 (0)	0 (0)
Color match	67 (61)	27.5 (25)	4.4 (4)	1.1 (1)	0 (0)
Anatomical form	76.9 (70)	22 (20)	1.1 (1)	0 (0)	0 (0)
Overall quality (esthetic)	72.2 (65)	26.7 (24)	1.1 (1)	0 (0)	0 (0)
Retention	89.1 (82)	8.7 (8)	1.1 (1)	1.1 (1)	0 (0)
Marginal adaptation	86.7 (78)	12.2 (11)	0 (0)	1.1 (1)	0 (0)
Occlusal contour and wear	83.7 (77)	16.3 (15)	0 (0)	0 (0)	0 (0)

Approximal anatomical form	83.7 (77)	16.3 (15)	0 (0)	0 (0)	0 (0)
Radiographic	87.2 (68)	11.5 (9)	0 (0)	1.3 (1)	0 (0)
Patient view	85.4 (76)	12.4 (11)	2.2 (2)	0 (0)	0 (0)
Overall quality (function)	82.4 (75)	16.5 (15)	1.1 (1)	0 (0)	0 (0)
Recurrence of caries	91.1 (82)	8.9 (8)	0 (0)	0 (0)	0 (0)
Tooth integrity	90 (81)	8.9 (8)	0 (0)	1.1 (1)	0 (0)
Periodontal response	88.8 (80)	8.9 (8)	1.1 (1)	1.1 (1)	0 (0)
Adjacent mucosa	88.9 (80)	8.9 (8)	0 (0)	2.2 (2)	0 (0)
Oral and general health	86.7 (78)	11.1 (10)	1.1 (1)	1.1 (1)	0 (0)
Overall quality (biologic)	86.7 (78)	13.3 (12)	0 (0)	0 (0)	0 (0)
FDI, Federation Dental International.					

Table 4: *Failure frequencies.*

Patient	Age	Gender	Tooth	Class	Material	Plaque index	Failure type	Follow up
1	31	F	2^{ed} Max Molar	II	Leucite	2	Esthetic, functional	10
2	64	F	1^{st} Man Molar	II	Leucite	1	Biologic	14
3	40	F	1^{st} Man Molar	III	Leucite	1	Biologic	26
4	42	F	2^{ed} Max Molar	I	Leucite	0	Biologic, fracture	13
5	52	F	1^{st} Max Premolar	II	Leucite	0	Biologic, functional, fracture	13
6	50	F	1^{st} Man Molar	III	Leucite	0	Fracture	21
7	40	M	2^{ed} Man Premolar	I	Lithium disilicate	1	Debonding	7
8	40	M	2^{ed} Man Molar	I	Lithium disilicate	1	Debonding	7

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9	58	M	1st Man Molar	I	Lithium disilicate	1	Debonding	7
10	41	F	2ed Man Molar	II	Leucite	1	Debonding	18
F: female, M: male, Max: Maxillary, Man: Mandibular,								

Table 5: *Binary logistic-regression analysis of the association between clinical parameters and endocrown failure.*

Variable	**Score**	**df.**	**Sig.**
Gender	0.080	1	0.777
Age	0.715	1	0.398
Tooth type	0.996	1	0.318
Jaw	2.778	1	0.096
Classification	0.145	1	0.703
Existence of facet wear	0.034	1	0.854
TMD	0.057	1	0.811
Bruxism	0.045	1	0.833
Gingival index	2.420	1	0.120
Material	0.490	1	0.484
Plaque index	0.926	1	<0.001

After the observation period, the overall success and survival rates were 89.1% and 95.7%, respectively. Ten of 92 endocrowns failed, due to esthetics, biological, functional, or debonding issues in table 4. Binary logistic regression table 5 revealed no significant effect of restoration class on failure rate ($p > 0.05$). Similarly, restoration material, facet wear, TMD, bruxism, gingival index, and tooth type showed no significant associations ($p > 0.05$). Only plaque index was significantly linked to failure ($p < 0.01$). Because all debonding failures involved the same cement (Panavia V5) and other cements were present in only a small number of cases, logistic regression was not performed for this parameter. Probing depth was excluded from regression analysis because all measurements were within normal limits (< 3 mm) (Tables 4,5).

Discussion

This retrospective evaluation assessed the clinical performance of posterior CAD/CAM ceramic endocrowns and examined how residual tooth tissue and other clinical parameters influenced failure rates. Endocrowns demonstrated high success and survival-89.1 % and 95.7 %, respectively-over a mean follow-up of 15 months, regardless of classification, material, or tooth type. However, the hypothesis that all parameters would be non-influential was only partially supported, since plaque index emerged as a significant predictor of failure ($p < 0.01$). Advances in adhesive protocols and reinforced ceramics have shifted restorative strategies toward more conservative options for ETT, such as endocrowns, onlays, and overlays, which preserve more tooth structure than traditional post–core crowns [27]. Preserving residual tooth structure is critical for biomechanical integrity and reduces fracture risk [23,28], so we specifically investigated whether classification by remaining tooth walls correlated with clinical outcomes. Despite limited failures and consequently modest statistical power, binary logistic regression revealed no significant effect of restoration class on failure. This aligns with Belleflamme et al and Taha et al. who also found no link between tooth-remnant thickness and clinical performance when proper preparation and isolation protocols are followed [23,29]. In contrast, some in vitro studies report increased fracture strength with greater occlusal thickness, suggesting that the relationship between residual structure and longevity remains unresolved and warrants further research with larger cohorts and longer follow-up (30-32). Our success rate mirrors those of previous clinical investigations [21,23,27]. Belleflamme et al. reported an 89.9 % success rate after 10 years of clinical service and Su-Ning Hu et al. observed a 92 % success over 1–3 years [23,27]. The favorable short-term outcomes likely reflect the monoblock design of endocrowns, which reduces interfaces and stress concentrations compared with multi-component post–core systems [1,8]. Debonding was the most common failure mode, accounting for 40 % of failures, consistent with Govare et al. (2). Endocrown retention depends on macro mechanical engagement in the pulp chamber and adhesive bonding at cavity margins. [16]. Overextending preparation can compromise marginal adaptation [33], yet studies show no fatigue resistance difference between 2 mm and 4 mm pulp-chamber depths [34]. Fortunately, debonded restorations can typically be re-cemented, making this failure non-catastrophic [2,35]. When restorations were grouped into lithiumdisilicate-based and leucite-based ceramics, material type did not significantly influence failure rates. This agrees with Hasanzade et al. [36] and Rigolin et al. [37], who reported similar marginal adaptation and survival for both materials. Although Belleflamme et al. noted a lower fracture rate for pressed lithium disilicate compared with leucite ceramics [23], our use of CAD/CAM ceramics may account for equivalent performance. Lithium disilicate remains the preferred material for its reliable bond to resin cements and long-term stability [38]. Emerging materials such as polyetherketoneketone (PEKK) also show promise; preliminary studies suggest PEKK endocrowns offer superior performance due to their mechanical properties and favorable stress distribution [40], but clinical validation is needed. Tooth type -molar versus premolar- also had no significant effect on failure rates in our study, although evidence in the literature is mixed. Several investigations favor molar endocrowns, citing premolars' higher lever arm forces and non-axial loading as risk factors [2,35,41], while Otto et al. and Thomas et al. found no difference [42,43]. Given that fewer premolars meet stringent endocrown indications, future studies should specifically address premolar restorations and their unique biomechanical challenges.

Occlusal risk factors including temporomandibular disorders, bruxism, and facet wear showed no significant associations with failure, likely due to uneven distribution and the limited event rate. Larger, more balanced cohorts are required to clarify these relationships. The finding that plaque index is a strong predictor of endocrown failure underscores the critical role of oral hygiene. Each one-unit increase in plaque index multiplied the odds of failure by 36, possibly because increased microbial load at the dentin cement interface promotes acid production that undermines adhesion and leads to deboning. All debonded restorations in this study occurred in patients with a plaque index score of 1. Accordingly, clinicians should emphasize rigorous plaque control and schedule closer follow-up for patients with elevated plaque scores. Future research should investigate whether enhanced hygiene protocols can reduce failure rates. This study's retrospective, single-center design introduces inherent biases—selection bias from including only documented follow-up cases, information bias from reliance on clinical records, heterogeneity in follow-up duration, and limited external validity due to the small number of failures. Examiner calibration, strict inclusion criteria, standardized FDI outcome measures, and multivariable regression helped mitigate these concerns, but residual confounding may persist. Additionally, the single follow-up per restoration precluded time-to-event analysis; prospective studies with scheduled serial assessments and Kaplan Meier analysis are recommended to validate and extend these findings.

Conclusion

CAD/CAM ceramic endocrowns are a reliable and conservative approach for restoring endodontically treated molars and premolars, including cases with extensive coronal tissue loss (Class III). A higher plaque index was significantly associated with restoration failure, highlighting the importance of maintaining optimal oral hygiene to reduce the risk of failure.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Sedrez-Porto JA, Rosa WL, da Silva AF, Munchow EA, Pereira-Cenci T. Endocrown restorations: A systematic review and meta-analysis. J Dent. 2016; 52: 8-14.
2. Govare N, Contrepois M. Endocrowns: A systematic review. J Prosthet Dent. 2020; 123: 411-418.
3. Patel S, Bhuva B, Bose R. Present status and future directions: vertical root fractures in root filled teeth. Int Endod J. 2022; 55: 804-826.
4. Fathi A, Ebadian B, Dezaki SN, Mardasi N, Mosharraf R, Isler S, et al. An umbrella review of systematic reviews and meta-analyses evaluating the success rate of prosthetic restorations on endodontically treated teeth. Int J Dent. 2022; 4748291.
5. De Carvalho MA, Lazari-Carvalho PC, Del Bel Cury AA, Magne P. Accelerated fatigue resistance of endodontically treated incisors without ferrule restored with CAD/CAM endocrowns. Int J Esthet Dent. 2021; 16: 534-552.
6. Ferrari M, Pontoriero DIK, Ferrari Cagidiaco E, Carboncini F. Restorative difficulty evaluation system of endodontically treated teeth. J Esthet Restor Dent. 2022; 34: 65-80.

7. de Andrade GS, Augusto MG, Leon GA, Brandão HC, Tribst JP, Dal Piva AM. Post-endodontic restorative treatments and their mechanical behavior: A narrative review. Dent Rev. 2023:100067.
8. Al-dabbagh RA. Survival and success of endocrowns: A systematic review and meta-analysis. J Prosthet Dent. 2021; 125: 415.
9. Ciobanu P, Manziuc MM, Buduru SD, Dudea D. Endocrowns- a literature review. Med Pharm Rep. 2023; 96: 358-367.
10. Pissis P. Fabrication of a metal-free ceramic restoration utilizing the monobloc technique. Pract Periodontics Aesthet Dent. 1995; 7: 83-94.
11. El Hakim BM, Nabil BA, Ezzat BE. Clinical assessment of marginal and internal fit of intra-radicular extention design versus no extention design endocrowns made of pressable lithium disilicate (randomized controlled clinical trial). J Pharm Negat. 2023: 4051-4058.
12. Qamar Z, Alghamdi AMS, Haydarah NKB, Balateef AA, Alamoudi AA, Abumismar MA, et al. In Vitro Evaluation of Lithium Disilicate Endocrowns and Post and Core Crowns-A Systematic Review. J Funct Biomater. 2023;14:
13. Lenz U, Bacchi A, Della Bona A. Biomechanical performance of endocrown and core-crown restorations: A systematic review. J Esthet Restor Dent. 2024; 36:303-323.
14. Gomes RL, Queiroz ACdS, Figueiredo VMGd. Endocrown as a restorative strategy in endodontically treated teeth: an integrative literature review. RGO-Revista Gaucha de Odontologia. 2022; 70:
15. Maravic T, Comba A, Mazzitelli C, Bartoletti L, Balla I, di Pietro E, et al. Finite element and in vitro study on biomechanical behavior of endodontically treated premolars restored with direct or indirect composite restorations. Sci Rep. 2022; 12: 12671.
16. Preethi D, Chander NG, Reddy JR. Endocrowns: a narrative review. J Pharm Negat. 2022: 3018-3025.
17. Topkara C, Keles A. Examining the adaptation of modified endocrowns prepared with CAD-CAM in maxillary and mandibular molars: A microcomputed tomography study. J Prosthet Dent. 2022; 127: 744-749.
18. All-heal AA. Biomechanical behavior of all-ceramic endocrowns fabricated using CAD/CAM: A systematic review. J Prosthodont Res. 2024; 68: 50-62.
19. Abduljawad DE, Rayyan MR. Marginal and internal fit of lithium disilicate endocrowns fabricated using conventional, digital, and combination techniques. J Esthet Restor Dent. 2022; 34:707-714.
20. Mezied MS, Alhazmi AK, Alhamad GM, Alshammari NN, Almukairin RR, Aljabr NA, et al. Endocrowns versus post-core retained crowns as a restoration of root canal treated molars - a review article. J Pharm Bioallied Sci. 2022; 14: S39-s42.
21. Thomas RM, Kelly A, Tagiyeva N, Kanagasingam S. Comparing endocrown restorations on permanent molars and premolars: a systematic review and meta-analysis. Br Dent J. 2020; 12: 1-9.
22. Hickel R, Peschke A, Tyas M, Mjor I, Bayne S, Peters M, et al. FDI world dental federation: clinical criteria for the evaluation of direct and indirect restorations-update and clinical examples. Clin Oral Investig. 2010; 14: 349-366.
23. Belleflamme MM, Geerts SO, Louwette MM, Grenade CF, Vanheusden AJ, Mainjot AK. No post-no core approach to restore severely damaged posterior teeth: An up to 10-year retrospective study of documented endocrown cases. J Dent. 2017; 63: 1-7.
24. Loe H, Silness J. Periodontal Disease in Pregnancy I. Prevalence and Severity. Acta Odontol Scand. 1963; 21: 533-551.
25. Silness J, Loe H. Periodontal Disease in Pregnancy. Ii. Correlation between Oral Hygiene and Periodontal Condtion. Acta Odontol Scand. 1964; 22:121-135.
26. Khan S, Cabanilla LL. Periodontal probing depth measurement: a review. Compend Contin Educ Dent. 2009; 30:12-14.
27. Hu SN, Li JW, Zhang XX, Wei R, Liang YH. Outcome of chairside CAD/CAM ceramic restorations on endodontically treated posterior teeth: a prospective study. BMC Oral Health. 2024; 24: 51.
28. Tribst JPM, Lo Giudice R, Dos Santos AFC, Borges ALS, Silva-Concílio LR, Amaral M, et al. Lithium disilicate ceramic endocrown biomechanical response according to different pulp chamber extension angles and filling materials. Materials (Basel). 2021; 14.
29. Taha D, Spintzyk S, Schille C, Sabet A, Wahsh M, Salah T, et al. Fracture resistance and failure modes of polymer infiltrated ceramic endocrown restorations with variations in margin design and occlusal thickness. J Prosthodont Res. 2018; 62: 293-297.
30. Haralur SB, Alamrey AA, Alshehri SA, Al-Ahram DS, Alfarsi M. Effect of different preparation designs and all ceramic materials on fracture strength of molar endocrowns. J Appl Biomater Funct Mater. 2020;18:
31. Lin ZX, Pan ZX, Ye QQ, Zheng ZQ, Lin J. Effect of occlusal thickness design on the fracture resistance of endocrowns restored with lithium disilicate ceramic and zirconia. Hua Xi Kou Qiang Yi Xue Za Zhi. 2020; 38: 647-651.
32. Tribst JPM, Dal Piva AMO, Madruga CFL, Valera MC, Borges ALS, Bresciani E, et al. Endocrown restorations: Influence of dental remnant and restorative material on stress distribution. Dent Mater. 2018; 34:1466-1473.
33. 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.
34. Rocca GT, Daher R, Saratti CM, Sedlacek R, Suchy T, Feilzer AJ, et al. Restoration of severely damaged endodontically treated premolars: The influence of the endo-core length on marginal integrity and fatigue resistance of lithium disilicate CAD-CAM ceramic endocrowns. J Dent. 2018; 68: 41-50.
35. Papalexopoulos D, Samartzi TK, Sarafianou A. A thorough analysis of the endocrown restoration: a literature review. J Contemp Dent Pract. 2021; 22: 422-426.
36. Hasanzade M, Sahebi M, Zarrati S, Payaminia L, Alikhasi M. Comparative evaluation of the internal and marginal adaptations of cad/cam endocrowns and crowns fabricated from three different materials. Int J Prosthodont. 2021; 34: 341-347.
37. Rigolin FJ, Miranda ME, Florio FM, Basting RT. Evaluation of bond strength between leucite-based and lithium disilicate-based ceramics to dentin after cementation with conventional and self-adhesive resin agents. Acta Odontol Latinoam. 2014; 27:16-24.
38. AlDabeeb DS, Alakeel NS, Al Jfshar RM, Alkhalid TK. Endocrowns: Indications, Preparation Techniques, and Material Selection. Cureus. 2023; 15: e49947.

39. Sorte N, Bhat V, Hegde C. Poly-ether-ether-ketone (PEEK): a review. Int J Recent Sci Res. 2017; 8: 19208-19211.
40. Abbas MH, Elerian FA, Elsherbiny AA, Elgohary NMM, Atout A. Influence of occlusal reduction design on the fracture resistance and biomechanical behavior of endocrowns restoring maxillary premolars. BMC Oral Health. 2024; 24:113.
41. Tzimas K, Tsiafitsa M, Gerasimou P, Tsitrou E. Endocrown restorations for extensively damaged posterior teeth: clinical performance of three cases. Restor Dent Endod. 2018; 43: e38.
42. Otto T, Mormann WH. Clinical performance of chairside CAD/CAM feldspathic ceramic posterior shoulder crowns and endocrowns up to 12 years. Int J Comput Dent. 2015; 18: 147-161.
43. Thomas RM, Kelly A, Tagiyeva N, Kanagasingam S. Comparing endocrown restorations on permanent molars and premolars: a systematic review and meta-analysis. Br Dent J. 2020.