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The impact of extended pulp chamber preparations on the clinical performance of endocrowns in Indian patients: A 1-year observational study

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ABSTRACT

Purpose: The limitations of foundation restorations have been reduced with the advent of endocrowns. Despite their success, the extent of endocrowns tooth preparation into the pulp chamber has not been fully explored in the literature. The study aimed to evaluate the clinical performance of endocrowns with 5 mm extended pulp chamber tooth preparations in Indian patients over a 1-year period using modified USPHS criteria.

Methods: The observational study recruited 36 participants with definite criteria. Ceramic crown was planned for all the participants. Conventional endocrown tooth preparation was made with 5 mm pulpal extension. Clinical assessments were made at 0-, 6- and 12-months intervals using modified USPHS criteria. The data was statistically analyzed using Friedman test and Wilcoxon signed rank test.

Results: One patient (2.8%) experienced loss of retention, marginal adaptation, and loss of anatomical form during 1-year follow up period. The majority of the participants (97.3%) reported no discomfort and high satisfaction. ($P < .05$) No opposing tooth wear was observed at 0- and 6-months. The results showed statistical significance in the parameters of retention, marginal adaptation, loss of anatomical form, and patient satisfaction. ($P < .05$).

Conclusion: The clinical performance of endocrowns with extended pulp chamber preparation was satisfactory for a period of 12 months.

1. Introduction

Dental caries is the primary cause for the loss of tooth structure. The primary objective of any treatment modality is to protect the teeth and preserve the structural integrity.¹ In situations of diseased teeth with pulpal, periodontal involvement and major loss of tooth structure are effectively managed by endodontic treatment approach. The management of damaged teeth poses clinical challenges. The position of teeth, periodontal health, restorative material and patient support are critical factors influencing the treatment success.² Additionally, other factors such as coronal microleakage, periapical health and involved clinical procedures plays a crucial role. Furthermore, endodontically treated teeth carry a higher risk of biomechanical failure than vital teeth. The optimal restorative treatment for an endodontically treated tooth varies depending on the clinical situation and remains a subject of debate. Nevertheless, the primary focus lies on the necessity to preserve the

tooth and periodontium through a less invasive procedure.³ Restoration of endodontically treated teeth with extensive coronal loss was conventionally achieved using foundation restoration.⁴ However, studies have shown that the use of post and core did not increase the retention or stability of the restoration.⁵ Additionally, other studies have revealed tooth fracture of teeth results from extensive preparation and obliteration of canals in posterior teeth due to stress transmission.^{6,7}

Pissis,⁸ Bindl⁹ have proposed endocrowns as an alternative to post and core restoration. Endocrowns are recommended for clinical situations of extensive coronal loss of tooth, inadequate occluso-gingival spaces, small tooth size and obliterated roots. They are easier to construct, economical, seals the access of canals, averts microleakage and supports re-treatment.^{10–14} They are less preferred in situations of bruxism or when adhesion is difficult to achieve. Endocrowns require less clinical time, offer superior esthetic properties, conserve tooth structure, effectively distribute stress, and are a less invasive procedure

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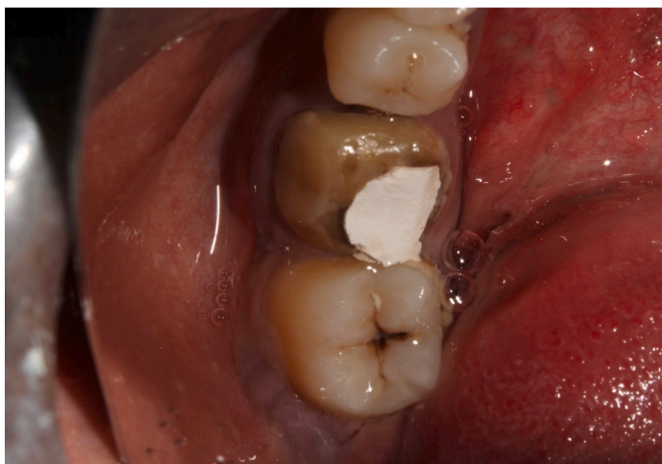


Fig. 1. Preoperative.

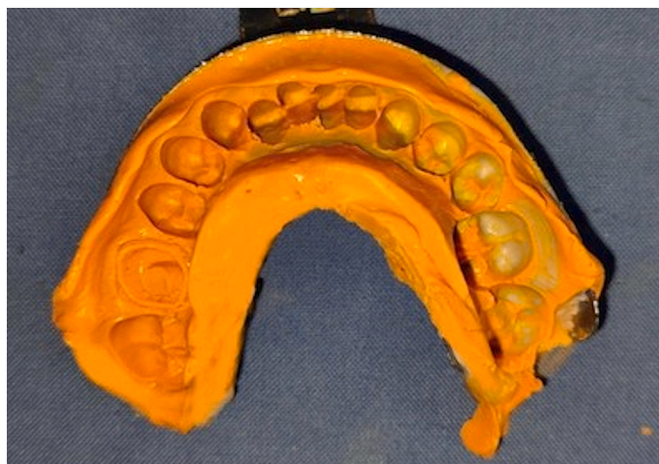


Fig. 3. Definitive impression.



Fig. 2. Endocrown preparation.

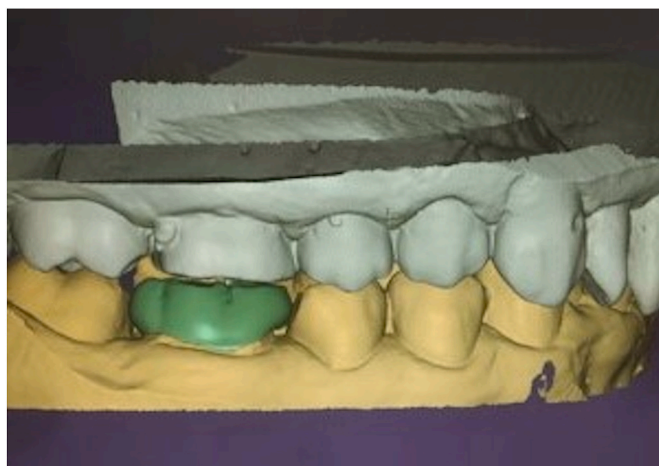


Fig. 4. CAD CAM design of crown.

compared to conventional crowns.^{15–22} Various studies have suggested that molars restored with endocrowns displayed better resistance to physiological chewing forces and reduced risk of restoration debonding.^{23–27}

Extending the endocrown preparation to pulp chambers has shown better mechanical performance and stress distribution in the tooth preparation.^{28–31} Although there are fewer invitro studies on extended pulp chamber preparation but no clinical studies have been reported. It is essential to assess this parameter, that is less estimated in literature to determine the clinical efficacy of endocrowns. Further research is required to fully understand the performance of endocrowns on the clinical impact of endocrowns.

The present study is aimed at evaluating the clinical performance of endocrowns with extended pulp chamber tooth preparations in Indian patients using Modified United States Public Health Service (USPHS) criteria at 0-, 6-, and 12- month time intervals. The Modified USPHS criteria considers various parameters, such as marginal integrity, anatomic form, color match, surface texture, secondary caries, and postoperative sensitivity, among others. These criteria provide a standardized and comprehensive approach to assess the success and longevity of dental restorations, including endocrowns.

2. Materials and methods

The observational study was approved by the Institutional review board. (SXXX/XXX/2020/MDS/No. 202). The estimated sample size

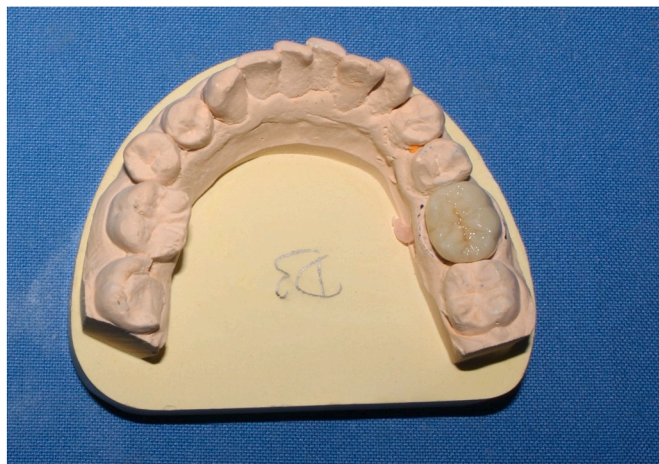


Fig. 5. Fabricated endocrown.

was 36 with 5% alpha error and 95% power, considering a with 20% dropout rate.¹⁶ The study included participants aged 45–75 years, comprising both genders, who required endocrowns for the mandibular first molar on either arch. Inclusion criteria involved participants with intact opposing natural occlusion, a minimum of 2–3 mm of coronal



Fig. 6. Post operative.

Table 1
Mean age of the participants.

Gender	N	Minimum	Maximum	Mean	Std. Deviation
Female	15	19	61	37.20	11.49
Male	21	20	55	34.10	10.17
Total	36	19	61	35.39	10.69

tooth structure, and root canal treated teeth with a good apical seal. Additionally, good oral hygiene and non-participation in other clinical studies were prerequisites for participation. Patients with orofacial muscle pain, jaw dysfunction, severe facial asymmetry, malignant diseases, allergies to the materials used, uncooperativeness, poor oral health, bruxism, or pregnancy were excluded from the study.

A standardized endocrown preparation was meticulously followed,

which included pulp chamber extension to a depth of 5 mm, supra-gingival chamfer margin, employing mechanochemical retraction, making addition silicone impression, selecting appropriate shade and providing an indirect provisional restoration (Figs. 1 and 2). Type 4 Gypsum working cast (Kalabhai Labstone, Stone Plaster, India) was made from the definitive impression (Fig. 3) and scanned with lab scanner (3 Shape, E4 scanner, Denmark). IPS e-Max (lithium di silicate) endocrowns were designed, milled and sintered (Figs. 4 and 5). The final crown was checked for marginal fit, occlusion, shade and luted with dual cure cement (Ivoclar vivadent, Variolink, Liechtenstein) (Fig. 6).

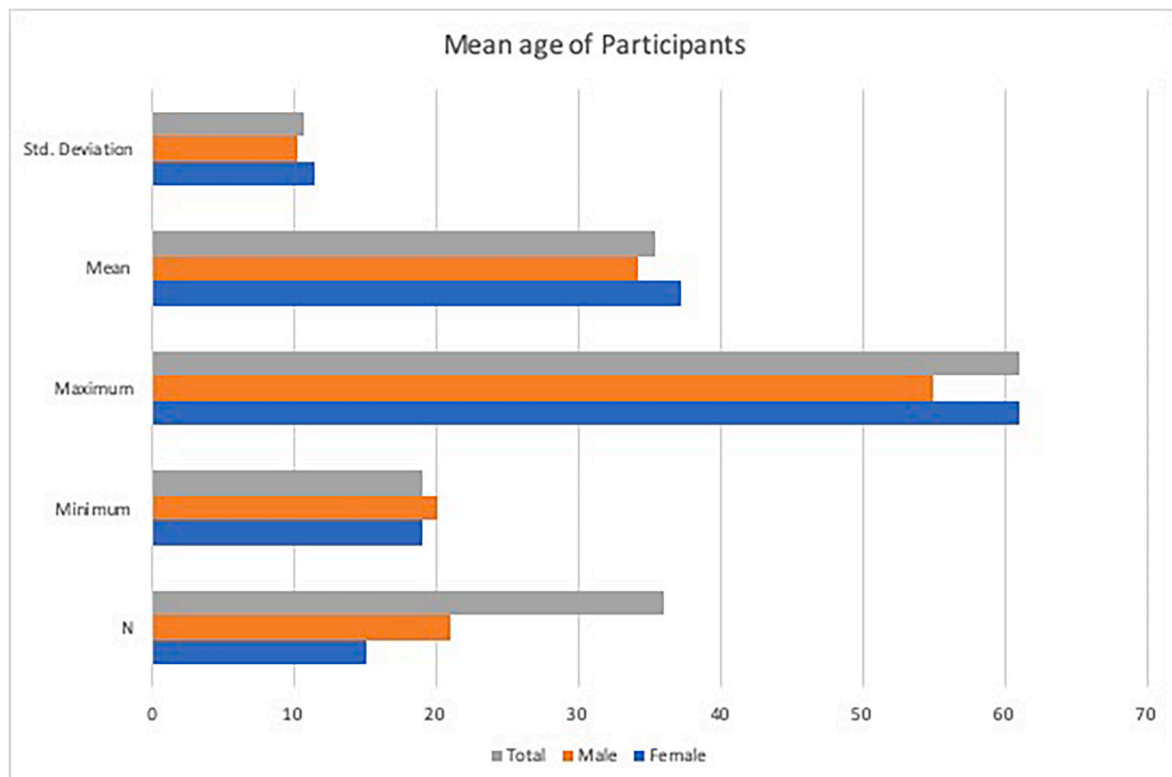
The clinical performance of endocrowns was evaluated at three significant time interval of 0-, 6- and 12- months using modified USPHS criteria. The raw data of various parameters were collected and analyzed with Friedman test. The pairwise comparisons across different time intervals were made using the Wilcoxon signed rank test (IBM SPSS Statistics, v19; IBM Corp, United States).

3. Results

The demographic data of the 36 participants (21 male and 15 female) was listed in Table 1 and visually represented in Graph1. The mean age

Table 2
Assessment of opposing tooth wear with simplified scoring criteria.

Month	Opposing tooth wear	Frequency	Percent
0	0	36	100
	1	0	0
	2	0	0
6	0	36	100
	1	0	0
	2	0	0
12	0	35	97.2
	1	1	2.8
	2	0	0



Graph 1. Mean age of the participants.

Table 3
Evaluation of USPHS criteria at 0,6, 12 months.

S. no	Modified USPHS criteria	Months	A	B	C	D
1	Retention	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	35 (97.2)	1(2.8)	–	–
2	Marginal adaptation	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	35 (97.2)	1(2.8)	–	–
3	Marginal discoloration	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
4	Loss of anatomical form	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	35 (97.2)	1(2.8)	–	–
5	Surface texture	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
6	Contact surface	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
7	Recurrent caries	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
8	Tooth integrity	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
9	Post operative sensitivity	0	36(100)	–	–	–
		6	36(100)	–	–	–
		12	36(100)	–	–	–
10	Patient complaints	0	21 (58.3)	15 (41.7)	–	–
		6	22 (61.1)	14 (38.9)	–	–
		12	24 (66.7)	12 (33.3)	–	–
11	Patient satisfaction	0	20 (55.6)	15 (41.7)	1 (2.8)	–
		6	15 (41.7)	19 (52.8)	2 (5.6)	–
		12	20 (55.6)	15 (41.7)	1 (2.8)	–

of males was 34.09 ± 10.16 years and for females it was 37.2 ± 11.49 years. No opposing tooth wear at 0- and 6-month intervals. Dentin exposure was noted in 2.8% of participants at 12-month interval (Table 2).

The results of modified USPHS criteria were documented in Table 3 and analyzed with Friedman test (Table 4). The analysis revealed statistically significant differences for retention, marginal adaptation, loss of anatomical form, and patient satisfaction (P < .05), while patient complaints showed no statistical significance. (P > .05) The mean ranks were constant for marginal discoloration, surface texture, contact surface, recurrent caries, tooth integrity, post-operative sensitivity.

The pairwise comparison of retention, marginal adaptation, loss of anatomical form, patient satisfaction, for various time intervals was analyzed with Wilcoxon signed rank test and which showed statistically insignificant differences. (P > .05) (Table 5) However, the pairwise-comparison analysis of these variables showed statistically significant. (P < .05)

4. Discussion

The study observed statistically significant results in many parameters of modified USPHS criteria. The loss of retention was observed in 1 patient (2.8%) during 12th month follow up. Al-Dabbagh¹¹ reported that 91.4% of endocrowns reported no loss of retention, demonstrating the loss of retention of endocrowns is comparatively less when

Table 4
Comparison of parameters across the time interval (Friedman’s test).

Parameter	Time (months)	Mean Rank	X ² value	p value
Retention	0	1.90	14.0	0.001
	6	1.90		
	12	2.19		
Marginal Adaptation	0	1.90	14.0	0.001
	6	1.90		
	12	2.19		
Marginal Discoloration	0	2.00		
	6	2.00		
	12	2.00		
Loss of anatomical form	0	1.90	14.0	0.001
	6	1.90		
	12	2.19		
Surface texture	0	2.00		
	6	2.00		
	12	2.00		
Contact surface	0	2.00		
	6	2.00		
	12	2.00		
Recurrent caries	0	2.00		
	6	2.00		
	12	2.00		
Tooth integrity	0	2.00		
	6	2.00		
	12	2.00		
Post op sensitivity	0	2.00		
	6	2.00		
	12	2.00		
Patient complaint	0	2.04	1.125	0.570
	6	2.04		
	12	1.92		
Patient satisfaction	0	1.82	8.581	0.014
	6	1.86		
	12	2.32		

Table 5
Pairwise comparison of parameters across time intervals.

S.no	Parameters	Months	Z statistics	P value
1	Retention	0–6	0.000	1.000
		6–12	–2.646	0.008
		0–12	–2.646	0.008
2	Marginal adaptation	0–6	0.000	1.000
		6–12	–2.646	0.008
		0–12	–2.646	0.008
3	Loss of anatomical form	0–6	0.000	1.000
		6–12	–2.646	0.008
		0–12	–2.646	0.008
4	Patient satisfaction	0–6	–0.333	0.739
		6–12	–2.419	0.016
		0–12	–2.351	0.019

compared to conventional crowns. The clinical observation was largely related to debonding and the luting cement used. The failure may be attributed to the bonding interface between ceramic and the luting cement. The result on the retention are in consensus with the literature and exhibited statistically significance.^{16–18} (P < .05)

Good marginal adaptation was reported in 0- and 6-months. Marginal adaptation loss was found in 1 patient at the end of 12th month due to retention failure. The studies conducted by Saglam et al. and Amini et al. displayed that endocrowns exhibited significantly higher internal adaptation and better marginal fit.^{19,20} The result of the study was similar to earlier studies and was statistically significant. (P < .05)

The study observed standardized protocol in finishing the restorations. The study found no changes in marginal discoloration, surface texture, contact surface, recurrent caries, tooth integrity and post-operative sensitivity. The study group included endodontically treated teeth, and all the participants had no sensitivity during follow up. The protocol followed aided in obtaining the alpha score for all these parameters at various time intervals. Hadzhigaev et al.²¹ reported alpha

scores in the stability of endocrowns in comparison with conventional fixed prosthesis, and Tzimas et al.²² reported alpha scores after 12-month recall in case studies.

The loss of anatomical form was reported in 1 patient at the end of 12-month observation. El-Ma'aïta et al.²³ found that no chipping was reported in lithium disilicate endocrowns, and fewer studies in literature have been observed in relation to material and endocrowns.^{19–22} The analysis is comparable to other material related studies and the data is statistically significant. ($P < .05$)

The majority of the participants displayed no discomfort and reported higher satisfaction. The satisfaction improved at 12th month compared to initial evaluation. Tan²⁴ observed that the patient satisfaction with the functional aspects of the FPDs and crowns was high and the study found higher satisfaction levels, with statistically significant data. ($P < .05$)

The study found no opposing tooth wear at 0–6-month of observation with mild enamel loss observed in 1 participant at the 12-month. Silva et al.²⁵ concluded that lithium di silicate glass ceramic materials exhibit excellent clinical performance and demonstrate acceptable abrasion compatibility with the opposing natural dentition. Additionally, the study found that IPS e.max endocrowns exhibited significantly better wear resistance. ($P < .05$)

Abduljawad¹² proved that digitally fabricated endocrowns showed superior marginal and internal fit compared to the conventionally fabricated endocrowns. The recruited subjects had regular patient education, a maintenance protocol, and no significant changes were observed in gingival and periodontal health during the interoperative phase. However, long-term clinical evaluation is required for further substantiation. The marginal fit of endocrowns was better than that of the conventional crown, and the results of the study showed good marginal properties and were statistically significant. ($P < .05$)

The preparation margins and pulp chamber extension depth play a role in determining the fracture resistance of endocrowns restoration. The most commonly used marginal forms are chamfer or 90°-degree butt joint. Yu²⁶ found that the chamfer margin had significantly better internal adaptation than those with a shoulder margin. Improved marginal fit was observed with endocrowns with chamfer finish lines.²⁷ Batista et al.²⁸ and Einhorn et al.²⁹ found that addition of ferrule to preparations did not increase the dentin surface available for bonding, so it was not included in the preparation due to varying observation in different studies. The study examined the impact of different pulpal depth preparation along with other controlled parameters of axial preparation, occlusal preparation, chamfer width, impression technique, fabrication materials, and cementation protocol.

The clinical performance of the endocrowns was determined using modified USPHS criteria, which assesses 11 parameters. Arunraj et al.,³⁰ Pascon et al.³¹ confirmed the validity of these criteria for determining the clinical performance of the crowns. The modified USPHS criteria was widely used to assess the clinical efficiency and have been found to be valid.

The study had generalized assessment of the prosthesis and recorded effective findings. It also had some limitations, such as short period of evaluation and minimalist study design. There have been fewer clinical studies on the extended pulp chamber parameter, and future studies using comparative trials, randomized clinical trials, or higher study designs can further support the study observations. The findings may also be associated with the short evaluation period, and longer-term evaluation can improve the clinical impact that can aid in establishment of standard operating protocol.

The study scope can be extended with additional parameters of evaluation as quality of life, microbial assessment, surface treatment of the crown, different luting materials, varying the tooth preparation parameter, type of teeth, multiple teeth, and comparison between various restorative material.

5. Conclusion

The endocrowns with extended pulp chamber showed positive results in clinical performance as assessed by the modified USPHS criteria. Further clinical studies with larger sample size and longer follow-up time are required to validate the results of the present study.

Declaration of competing interest

No conflicts of interest.

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Nil.

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