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Original Research Article

Effect of Intraradicular Extension Length on Fracture Resistance of Lithium Disilicate Endocrowns in Mandibular Premolars: An In Vitro Study

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ABSTRACT

Introduction: Restoration of endodontically treated premolars with extensive coronal destruction is challenging. Conventional post-and-core crowns require post-space preparation, which may compromise radicular dentin. Lithium disilicate ceramic endocrowns offer a minimally invasive adhesive alternative using the pulp chamber for retention. This in vitro study evaluated the effect of varying intraradicular extension lengths on fracture resistance and failure mode of endodontically treated single-rooted mandibular premolars.

Methodology: Thirty-two extracted human single-rooted mandibular premolars were endodontically treated, decoronated 2 mm coronal to the cementoenamel junction, and randomly divided into four groups (n = 8). Group 1 received a 5 mm glass fiber post, composite core, and lithium disilicate crown. Groups 2–4 received lithium disilicate endocrowns with 3, 4, and 5 mm intraradicular extensions, respectively. Restorations were cemented with dual-cure self-adhesive resin cement. Specimens were loaded at 45° to the long axis at 0.5 mm/min until fracture.

Results: Mean fracture loads were 620.89 ± 166.19 N (Group 1), 855.62 ± 90.68 N (Group 2), 781.03 ± 101.40 N (Group 3), and 624.66 ± 126.90 N (Group 4). A significant intergroup difference was observed ($F = 7.033$; $p = 0.001$). Group 2 showed the highest favorable fracture rate (87.5%), whereas Group 4 demonstrated the highest unfavorable fracture rate (87.5%; $\chi^2 = 10.687$; $p = 0.049$).

Conclusion: Extensions beyond 3 mm did not provide an additional increase in fracture resistance, while the 5 mm extension group demonstrated the highest proportion of unfavorable fractures.

Keywords: Endocrown, Lithium disilicate, Fracture resistance, Intraradicular extension, Endodontically treated premolars, Glass fiber post, Failure mode, Adhesive cementation.

BACKGROUND

Endodontically treated teeth (ETT) are inherently more susceptible to biomechanical failure than their vital counterparts owing to cumulative loss of coronal and radicular dentin resulting from carious destruction, endodontic access cavity preparation, and post space instrumentation [1]. This structural compromise necessitates a robust and biomechanically compatible

restorative strategy capable of redistributing functional loads while preserving the maximum amount of residual tooth structure.

The traditional approach to restoring extensively damaged ETT involves an intraradicular post, composite resin or cast metal core build-up, and a full-coverage ceramic crown. While this technique has demonstrated acceptable long-term clinical performance, post space preparation inevitably removes radicular dentin, reducing root wall thickness and predisposing the tooth to vertical root fracture or root perforation — particularly with rigid metal posts [2]. Glass fiber posts represented a significant advancement, as their elastic modulus more closely approximates that of dentin, enabling more homogeneous stress distribution along the root [3]. Nevertheless, post space preparation remains an irreversible iatrogenic procedure with inherent biomechanical risks.

In response to these limitations, adhesive restorative dentistry introduced the endocrown — a monolithic all-ceramic restoration anchored entirely within the pulp chamber without intraradicular post placement. The monoblock principle was first described by Pissis [4], and the term "endocrown" was established by Bindl and Mörmann, who defined it as an adhesive ceramic restoration retained by the pulp chamber walls and the peripheral cervical margin [5]. By integrating the crown, core, and intrapulpal retention into a single unit, the endocrown reduces the number of adhesive interfaces, potentially decreasing debonding risk while offering macromechanical retention through pulpal walls and micromechanical retention through adhesive cementation [6].

Additional clinical advantages of endocrowns include suitability in cases of limited interocclusal space, narrow or complex root canal anatomy, and calcified root canals where post placement is contraindicated. Endocrowns also offer reduced chairside time, simplified fabrication, and the possibility of endodontic retreatment without compromising the restoration [7]. However, their application in single-rooted premolars remains debated. Premolars possess smaller pulp chamber volumes, more complex root morphology, and are subjected to higher lateral and deflective occlusal forces compared to molars, which may adversely affect crown-to-root ratio and increase the risk of debonding or fracture [8]. While several investigations have reported fracture resistance of endocrowns comparable to or exceeding that of conventional post-and-core restorations, conflicting findings persist [9].

The depth of intraradicular extension is a critical variable in endocrown design. Greater extension may theoretically augment bonding surface area and macromechanical retention; however, it concurrently requires removal of additional radicular dentin and may concentrate tensile stresses within the root, increasing the risk of catastrophic failure [10]. Previous studies have yielded inconsistent findings regarding optimal extension depth [11]. Lithium disilicate ceramic (IPS e.max CAD; Ivoclar Vivadent) has become a preferred material for endocrown fabrication owing to its excellent flexural strength, fracture toughness, and reliable adhesive bonding [12]. Nevertheless, its relatively higher elastic modulus compared to dentin raises concerns that excessive intraradicular extension may transfer stress apically to remaining radicular structure [13,14].

Therefore, the present in vitro study was designed to evaluate and compare the fracture resistance and failure mode of endodontically treated single-rooted mandibular premolars restored with a conventional glass fiber post-and-core supported lithium disilicate ceramic crown (Group 1) versus lithium disilicate ceramic endocrowns with intraradicular extensions of 3 mm (Group 2), 4 mm (Group 3), and 5 mm (Group 4). The null hypothesis was that there would be no statistically significant difference in fracture resistance or failure mode distribution among the four restoration designs.

MATERIALS AND METHODS

Study design and ethical considerations

This in vitro study was conducted in the Department of Prosthodontics and Crown & Bridge, PDM University, Bahadurgarh, Haryana, India. Ethical clearance was obtained from the Institutional Ethics Committee of PDM Dental College and Research Institute, Bahadurgarh, Haryana, India (Application No.: PDM/IEC/Prostho/02/2025). A total of 32 specimens were included, with 8 specimens allocated to each group. The sample size was selected based on the experimental design and comparable previously published in vitro studies.

Specimen selection and preparation

Human permanent single-rooted mandibular premolars were collected from the Department of Oral and Maxillofacial Surgery following informed patient consent. Inclusion criteria comprised teeth with a single, straight root canal, fully formed apical constriction, and comparable root dimensions. Teeth with visible root cracks, apical dilacerations, surface defects, previous restorations, or prior endodontic treatment were

excluded. Thirty-two teeth meeting the inclusion criteria were selected (Figure 1).



Figure 1: Freshly extracted human permanent single-rooted mandibular premolars selected for the study.

All specimens were cleaned using an ultrasonic scaler to remove calculus and soft tissue remnants, stored in 0.5% chloramine-T solution at 4°C for up to three months, and subsequently transferred to normal saline at 37°C until testing.

Each tooth was decoronated perpendicular to the long axis 2 mm coronal to the cementoenamel junction using a water-cooled diamond disc (Figure 2), standardizing residual root length across all specimens. Endodontic treatment was performed using the crown-down technique with ProTaper nickel-titanium rotary instruments (Dentsply Sirona). Copious irrigation was performed after each instrument change with 3% sodium hypochlorite alternating with normal saline. Working length was established 1 mm short of the apical constriction and confirmed radiographically. Root canals were obturated using cold lateral condensation with matched gutta-percha cones and AH Plus sealer (Dentsply DeTrey). Canal orifices were sealed, and specimens were stored in normal saline for 48 hours prior to restoration.



Figure 2: Decoronated specimens standardized 2 mm coronal to the cementoenamel junction, prior to endodontic treatment

Group allocation and restoration protocol

Specimens were randomly allocated into four groups using a computer-generated randomization sequence (n = 8 per group):

1. **Group 1 (Control):** Conventional restoration comprising a 5 mm prefabricated glass fiber post, nanohybrid composite resin core build-up, and lithium disilicate ceramic crown.
2. **Group 2:** Lithium disilicate ceramic endocrown with 3 mm intraradicular extension.
3. **Group 3:** Lithium disilicate ceramic endocrown with 4 mm intraradicular extension.
4. **Group 4:** Lithium disilicate ceramic endocrown with 5 mm intraradicular extension.

Group 1: Glass fiber post and core protocol

Post space preparation was accomplished using calibrated Peeso reamers, ensuring a minimum 4 mm apical gutta-percha seal. Glass fiber posts were disinfected with 99.9% ethanol for 60 seconds, air-dried, and treated with a silane coupling agent (Figure 3). Dual-cure self-adhesive resin cement (RelyX U200, 3M ESPE) was applied to the post canal using a lentulo spiral prior to post seating. Excess cement was removed, and the restoration was light-cured for 40 seconds followed by complete chemical cure. The coronal post extension was adjusted to achieve a standardized 5 mm core height. Composite resin cores were fabricated using silicone matrices with nanohybrid composite resin (Tetric EvoCeram, Ivoclar Vivadent). Lithium disilicate ceramic crowns (IPS e.max CAD) were fabricated by CAD/CAM milling, crystallized per manufacturer instructions, and adhesively cemented.



Figure 3: Application of silane coupling agent to the glass fiber post surface prior to cementation in Group 1 specimens

Groups 2–4: Endocrown Protocol

For endocrown groups, gutta-percha was selectively removed from the coronal canal segment to create intraradicular spaces of 3 mm, 4 mm, and 5 mm for Groups 2, 3, and 4, respectively, using Gates Glidden drills under magnification. The pulp chamber and intraradicular extension were shaped to receive the endocrown. All-ceramic endocrowns were designed using CAD software and milled from lithium disilicate ceramic blocks (IPS e.max CAD; Ivoclar Vivadent) followed by crystallization in a ceramic furnace (Figure 4). Fit and marginal integrity of each restoration were verified prior to cementation. Endocrowns were adhesively cemented using dual-cure self-adhesive resin cement (RelyX U200, 3M ESPE) and light-cured for 40 seconds.

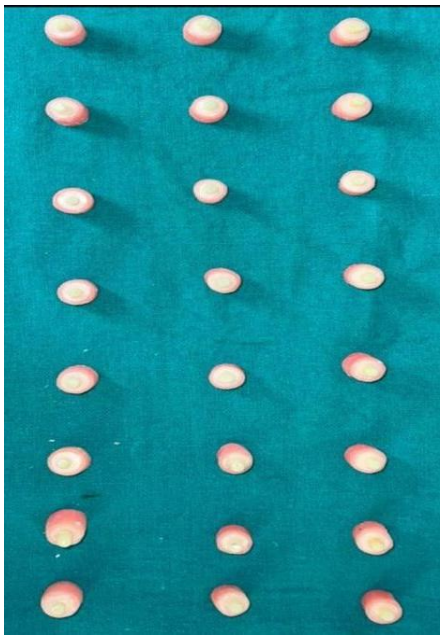


Figure 4: All 32 decoronated specimens arranged following preparation of the endocrown intraradicular extension spaces (Groups 2–4) and post space (Group 1)

Periodontal ligament simulation and specimen mounting

To simulate physiological periodontal support, each root was coated with a uniform wax layer (~0.2–0.3 mm) extending to 2 mm below the cervical line. Roots were embedded in self-curing acrylic resin cylinders; specimens were then immersed briefly in warm water to dissolve the wax, creating a standardized gap between the root surface and acrylic resin (Figure 5). This space was filled with silicone impression material to simulate the periodontal ligament, and specimens were reinserted and allowed to polymerize (Figure 6).

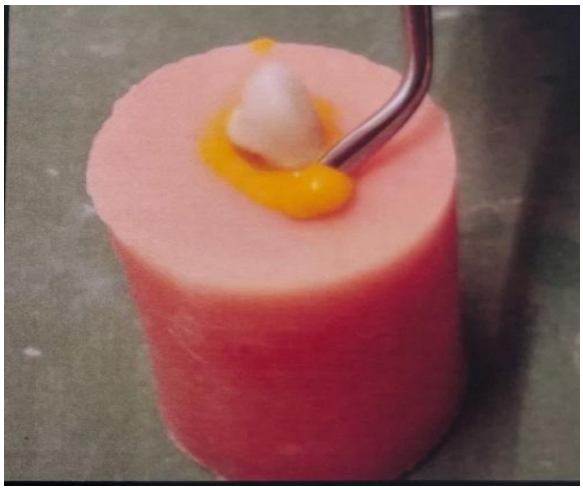


Figure 5: Specimen embedded in acrylic resin cylinder during periodontal ligament simulation. Silicone impression material is being injected into the gap created by wax elimination to replicate the periodontal ligament.

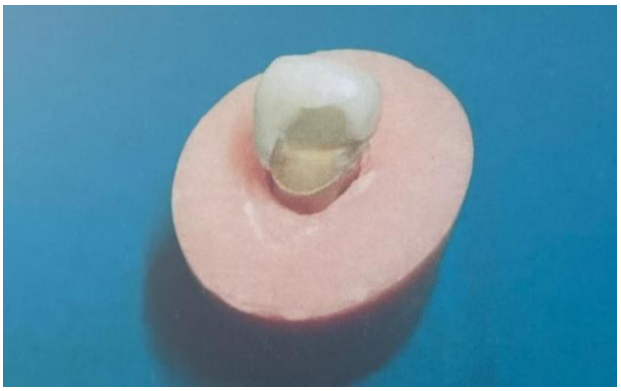


Figure 6: Representative specimen (endocrown group) mounted in acrylic resin block with simulated periodontal ligament, prepared for fracture resistance testing

Fracture resistance testing

All specimens were subjected to static compressive loading using a universal testing machine (Instron, Model 3367). Each specimen was oriented at 45° to the loading axis. A 6 mm diameter stainless-steel spherical indenter was positioned on the inner incline of the buccal cusp, and load was applied at a crosshead speed of 0.5 mm/min until fracture. The maximum load at failure was recorded in Newtons (N).

Failure mode classification

Following fracture testing, all specimens were examined under stereomicroscopic magnification (×10). Failure modes were classified as:

1. **Favorable (repairable):** Fractures limited to the restoration, core fracture, or cervical root fractures amenable to retreatment or re-restoration (Figure 7).

2. **Unfavorable (non-repairable):** Vertical root fractures, oblique fractures below the cervical third, or fractures rendering the tooth unrestorable.

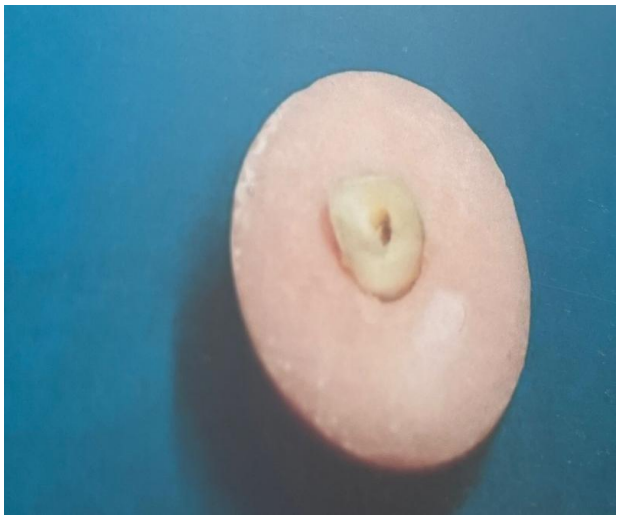


Figure 7: Representative specimen illustrating a favorable (repairable) fracture mode — fracture confined to the cervical region, above the alveolar crest, amenable to re-restoration

Statistical analysis

Data were recorded in Microsoft Excel and analyzed using SPSS software (version 26.0; IBM, USA). Descriptive statistics including mean, standard deviation (SD), and standard error (SE) were computed. Normality was assessed using the Shapiro–Wilk test, and homogeneity of variance was confirmed by Levene's test. Inter-group fracture resistance comparisons were performed using one-way ANOVA with post-hoc Tukey HSD analysis. Failure mode distributions were analyzed using the chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

Fracture resistance

Descriptive statistics for fracture load across all groups are summarized in Table 1. Group 2 (3 mm endocrown) exhibited the highest mean fracture load (855.62 ± 90.68 N), followed by Group 3 (4 mm endocrown; 781.03 ± 101.40 N), Group 4 (5 mm endocrown; 624.66 ± 126.90 N), and Group 1 (control; 620.89 ± 166.19 N). The fracture resistance ranking was therefore: Group 2 > Group 3 > Group 4 ≈ Group 1.

One-way ANOVA revealed a statistically significant difference in fracture load among the four groups ($F = 7.033$; $p = 0.001$). Post-hoc Tukey analysis (Table 2) demonstrated that Group 2 exhibited significantly higher fracture resistance than Group 1 (mean difference: 234.73 N; $p = 0.001$) and Group 4 (mean difference: 230.96 N; $p = 0.001$). Group 3 also demonstrated significantly greater fracture load compared to Group 1 (mean difference: 160.15 N; $p = 0.016$) and Group 4 (mean difference: 156.37 N; $p = 0.018$). No statistically significant differences were observed between Group 1 and Group 4 (mean difference: 3.78 N; $p = 0.952$) or between Group 2 and Group 3 (mean difference: 74.59 N; $p = 0.242$).

Table 1: Intergroup comparison of fracture load — One-way ANOVA

Group	Mean (N)	SD	SE	f value	p value	Significance
Group 1 (Control)	620.89	166.19	58.76	7.033	0.001	**Significant***
Group 2 (3 mm EC)	855.62	90.68	32.06	—	—	—
Group 3 (4 mm EC)	781.03	101.40	35.85	—	—	—
Group 4 (5 mm EC)	624.66	126.90	44.86	—	—	—

EC: Endocrown; SD: Standard Deviation; SE: Standard Error. *p < 0.05 considered statistically significant.

Table 2: Pairwise comparison of fracture load — Post-Hoc Tukey HSD analysis

Comparison	Mean Difference (N)	Std. Error	P Value	Significance
Group 1 vs Group 2	−234.73	62.36	0.001	Significant*
Group 1 vs Group 3	−160.15	62.36	0.016	Significant*
Group 1 vs Group 4	−3.78	62.36	0.952	Non-Significant
Group 2 vs Group 3	74.59	62.36	0.242	Non-Significant
Group 2 vs Group 4	230.96	62.36	0.001	Significant*
Group 3 vs Group 4	156.37	62.36	0.018	Significant*

HSD: Honestly Significant Difference. *p < 0.05 considered statistically significant.

Table 3: Distribution of failure modes among study groups — Chi-square analysis

Group	Unfavorable n (%)	Favorable n (%)	Chi-Square (χ^2)	p value	Significance
Group 1 (Control)	4 (50.0%)	4 (50.0%)	10.687	0.049	**Significant***
Group 2 (3 mm EC)	1 (12.5%)	7 (87.5%)	—	—	—
Group 3 (4 mm EC)	6 (75.0%)	2 (25.0%)	—	—	—
Group 4 (5 mm EC)	7 (87.5%)	1 (12.5%)	—	—	—

EC = Endocrown. Chi-square test; *p < 0.05 considered statistically significant

Failure mode distribution

The distribution of favorable and unfavorable failure modes is presented in Table 3. group 2 demonstrated the highest proportion of favorable (repairable) fractures (87.5%; 7/8 specimens), whereas Group 4 exhibited the highest proportion of unfavorable (non-repairable) fractures (87.5%; 7/8 specimens). Group 1 showed an equal distribution of favorable and unfavorable failures (50% each), while Group 3 predominantly exhibited unfavorable fractures (75%; 6/8 specimens).

Chi-square analysis revealed a statistically significant difference in failure mode distribution among the four groups (χ^2 = 10.687; p = 0.049). Chi-square analysis revealed a statistically significant difference in failure mode distribution among the four groups (χ^2 = 10.687; p = 0.049). Group 2 showed the highest proportion of favorable failures (87.5%), whereas Group 4 showed the highest proportion of unfavorable failures (87.5%). No statistically significant differences in failure mode were observed between Groups 1 and 2, 1 and 3, 1 and 4, or 3 and 4.

DISCUSSION

The aim of the present in vitro study was to assess the effects of different intraradicular extension lengths on the fracture resistance and failure pattern of lithium disilicate ceramic endocrowns used to restore endodontically treated single-rooted mandibular premolars. The null hypothesis was rejected because there were statistically significant differences in both fracture resistance (F = 7.033, p = 0.001) and mode distribution of failures (χ^2 = 10.687, p = 0.049) when comparing the experimental groups.

The 3 mm intraradicular extension group (Group 2; 855.62 N) had the highest mean fracture resistance, significantly higher than both the conventional glass fiber post-and-core group (Group 1; 620.89 N) and 5 mm extension group (Group 4; 624.66 N). The results are in agreement with Tavano KTA et al. [15] who found that the fracture strength of lithium disilicate endocrowns was superior to the glass fiber post-retained conventional crown in molar teeth of the mandible, and also in line with the growing consensus that adhesively bonded ceramic endocrowns can be as strong or stronger than conventional post-and-core restorations.

This improvement in performance of the 3 mm endocrown could be explained by the conservation of the radicular dentin, which preserves a better structural integrity and limits stress propagation. Lithium disilicate ceramic has high flexural strength, high fracture toughness, and excellent adhesive bond with resin cement, which allows for a very efficient distribution of stress across the tooth-restoration complex, without requiring extensive preparation of the radicular dentine. Lenz U et al. [16] further confirmed this finding and reported that endocrowns have a biomechanical behavior superior to post-and-core restorations, in addition to reducing the restorative interface and retaining tooth structure. AlDabeeb DS et al. [5] also noted that the quality of the adhesive cementation is more of a determining factor for the success of an endocrown than its depth of extension.

Similarly, Aldesoki et al. [17] conducted a finite element analysis study which showed that the 3 mm pulpal extension design with an axial extension produced about 15% less von Mises stresses in the restoration and residual tooth structure than the 5 mm pulpal extension design with an axial extension in maxillary premolars. These biomechanical findings may provide a possible mechanistic explanation for the higher fracture resistance observed in the 3 mm endocrown group in the present study.

No statistically significant difference was observed between the 3 mm and 4 mm endocrown groups (p = 0.242). The 5 mm endocrown group did not differ significantly from the conventional glass fiber post-and-core group (p = 0.952). However, the 3 mm and 4 mm endocrown groups demonstrated significantly greater

fracture resistance than the 5 mm endocrown group (p = 0.001 and p = 0.018, respectively). Deeper extensions would theoretically offer more bonding surface area, but they also require more removal of radicular dentin and result in a decreased structural reserve of the root, with increased tensile stresses apically. Some of these findings differ from those reported by Rocca et al. [18], who observed differences in endocore length between 2 mm and 4 mm designs. This difference may be due to methodological differences, with static compressive loading at 45° creating a higher stress on the restoration-tooth interface compared with cyclic fatigue, highlighting the importance of residual dentin thickness.

Clinically important supplementary evidence was obtained through failure mode analysis. The most favourable and possible repairable fractures were seen in Group 2 (87.5%) and he highest proportion of favorable (repairable) fractures was observed in Group 2 (87.5%), whereas Group 4 demonstrated the highest proportion of unfavorable (non-repairable) fractures (87.5%). This inverse relationship of extension depth and reparability highlights the clinical importance of preserving radicular dentin. Repairable fractures provide a chance for re-treatment or re-restoration, greatly enhancing the prognosis for long-term tooth survival. The higher percentage of unfavorable failures observed in the 5 mm group may be related to greater stress concentration within the remaining radicular dentin, as suggested by previous biomechanical studies [19,20]. The findings confirm the concept that assessment of fracture resistance and failure mode should be done simultaneously when considering restorative strategies.

The mean fracture loads recorded for all groups exceeded the physiological masticatory force range reported for premolars (150–300 N); this indicates that each restoration design tested may be able to resist normal functional loading. The higher mean fracture load observed for the 3 mm endocrown may indicate a greater margin of resistance under the present experimental loading conditions. However, the clinical performance of this design under parafunctional activity, bruxism, or excessive occlusal loading cannot be inferred from the present in vitro findings.

LIMITATIONS

This study has some inherent limitations due to the in vitro design. Complex intraoral conditions such as thermal cycling, long-term cyclic fatigue, degradation of adhesive interfaces in the oral cavity and periodontal adaptation could not be simulated by the experimental protocol. Small sample size (n = 8 per group) and evaluation of a single ceramic material reduce the generalizability. Observations like these require future long-term randomized clinical trials and accelerated ageing testing to validate and confirm clinical guidelines. Furthermore, the use of static compressive loading does not fully reproduce the cyclic, multidirectional, and variable loading conditions encountered clinically.

CONCLUSION

The 3 mm and 4 mm lithium disilicate ceramic endocrowns showed greater fracture resistance than the conventional glass fibre post and core supported crowns. The 3 mm extension had the highest fracture resistance and the highest proportion of favorable (repairable) fractures (87.5%). There was no significant difference in fracture resistance when increasing the intraradicular extension to 5 mm, and this extension had the highest percentage of unfavorable fractures. There was no direct correlation between the increasing extension depth and fracture resistance. Thus, within the conditions of this in vitro study, the 3 mm intraradicular extension demonstrated the most favorable combination of fracture resistance and failure mode among the tested endocrown designs.

REFERENCES

1. Caussin E et al. Materials (Basel). 2024 Jul 28;17(15):3736. [PMID: 39124400]
2. Saad KB et al. BMC Oral Health. 2023;23(1):992. [PMID: 38082401]
3. Madfa AA. Cureus. 2023 Aug 6;15(8):e43056. [PMID: 37680412]
4. Wazurkar S et al. Cureus. 2024 May 20;16(5):e60686. [PMID: 38903384]
5. AlDabeeb DS et al. Cureus. 2023 Dec 5;15(12):e49947. [PMID: 38058523]
6. Mezied MS et al. J Pharm Bioallied Sci. 2022 Jul;14(Suppl 1):S39-S42. [PMID: 36110800]
7. Dogui H et al. Case Rep Dent. 2018 Aug 30;2018:1581952. [PMID: 30228915]
8. Miluna-Meldere S et al. Int J Dent. 2025;2025:5061799. [PMID: 41122308]
9. Kontakou Zoniou A et al. Medicina (Kaunas). 2025;61(9):1562. [PMID: 41010953]
10. Kuşuçar AN et al. BMC Oral Health. 2025 Mar 27;25(1):443. [PMID: 40148885]
11. Taha AI et al. BMC Oral Health. 2025 Jul 8;25(1):1127. [PMID: 40629344]
12. Kashwani R et al. Community Pract. 2024;21(5):123–137. [DOI: 10.5281/zenodo.11485287]
13. Soliman M et al. J Funct Biomater. 2025;16(6):221. [PMID: 40558907]
14. Biacchi GR et al. Oper Dent. 2012;37(2):130–136. [PMID: 21942234]
15. Tavano KTA et al. BMC Oral Health. 2020 Nov 3;20(1):300. [PMID: 33143720]
16. Lenz U et al. J Esthet Restor Dent. 2024 Feb;36(2):303-323. [PMID: 37571973]

17. Aldesoki M et al. J Mech Behav Biomed Mater. 2022 Sep;133:105309. [PMID: 35689987]
18. Rocca GT et al. J Dent. 2018 Jan;68:41-50. [PMID: 29107134]
19. Aslan T et al. Odontology. 2024 Jul;112(3):798-810. [PMID: 38184512]
20. Kırmalı Ö et al. Eur J Dent. 2026 Jun 3. [PMID: 42235543]

Ethical Approval: Ethical clearance was obtained from the Institutional Ethics Committee of PDM Dental College and Research Institute, Bahadurgarh, Haryana, India (Application No.: PDM/IEC/Prostho/02/2025).

Declaration of Patient Consent: Informed consent was obtained from the patients for the use of extracted teeth for research purposes.

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AUTHOR CONTRIBUTIONS

Monika Ahlawat: Conceptualization, study design, methodology, specimen collection and preparation, experimental procedures, data collection, statistical analysis, interpretation of results, and manuscript writing.

Ankit Ahlawat: Methodology, supervision, data validation, interpretation of results, critical review of the manuscript, and final approval of the version to be published.

Both authors contributed to the study and approved the final manuscript.

ABBREVIATIONS USED IN THE STUDY

a) ANOVA: Analysis of Variance
b) CAD/CAM: Computer-Aided Design/Computer-Aided Manufacturing
c) EC: Endocrown
d) ETT: Endodontically Treated Teeth
e) HSD: Honestly Significant Difference
f) N: Newton
g) SD: Standard Deviation
h) SE: Standard Error
i) SPSS: Statistical Package for the Social Sciences
j) χ^2: Chi-Square

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